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C. M. HARDIN, *Director* . . . . . J. G. DUNCAN, *Editor*

THE QUARTERLY BULLETIN

The Quarterly Bulletin of the Michigan Agricultural Experiment Station is issued in February, May, August and November. It presents: 1) progress reports on long-term major research projects; 2) final reports on short-term projects and 3) short, timely articles of a popular nature that bring together information from various sources on subjects in which farmers are interested.

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FACTORS AFFECTING RETAIL PEACH SALES[1]

By E. H. HARTMANS and M. E. CRAVENS, JR.
SECTION OF AGRICULTURAL ECONOMICS

THIS STUDY was one of a series designed to determine the kind of peaches that customers desire and to find ways by which growers and dealers can provide fruit having this desired quality.

During a five-week period of the 1948 marketing season, detailed observations were made on peach sales in selected retail stores in the vicinty of Detroit. The stores were visited daily and records were taken on quality, selling prices, volume of sales, and number of customers visiting each store daily. Under the heading of "quality" were included appearance, firmness, shade of green color, percent of red color and of bruised peaches, occurrence of rots and other defects and size of peaches. Observations were also made on both the amount and the apparent cause of waste. In all, 176 store-day records were obtained for pound sales.

GENERAL OBSERVATIONS

Considerable variation in peach quality was apparent from day to day, but no significant variation was found among different hours of the day.

Both quality and price were found to have a significant effect on the rate of sale. Peculiarities in peach marketing (as well as in the marketing of other perishables) resulted, however, in little apparent relationship between quality and price.

Two major factors contribute to this, one of which is the impossibility of judging today how a given lot[2] of peaches will look two days or more afterwards. Everything that has gone into the production, grading, and packing of these peaches plus the temperature and handling dur-

[1]These records were obtained in the stores of the A & P Tea Company, the Kroger Company, and the C. F. Smith Company. The officials of these companies, their store managers, clerks, and others were very cooperative and helpful. The writers wish to express sincere appreciation for their contributions to this study.

[2]By lot is meant the peaches marketed as a "lot" or load by one producer.

ARTICLE 32-1

ing marketing will have a different effect on each lot of peaches. The buyer at the country point must judge the peaches on what he sees of them and what he knows about the producer. He cannot be expected to predict accurately what each lot of peaches will become.

The other factor causing variation in the relationship of quality and price is due to the seasonality of peach production and marketing. Because of differences in the volume of marketings the wholesale price of fine quality peaches one day may be less than that of a poorer quality on another day. These retailers were apparently not able to reflect these quality variations in prices but based retail on wholesale prices only.

No attempt was made to compare the purchase policies of the three chains for their effects on quality and price. Each of the three chains had one price for peaches for pound sales for all stores in the chain and for all peaches in a store. The observed variation in quality from day to day for the stores of each chain was greater than that among the chains studied. If still other chains and independent stores had been studied there would have been still greater differences in retail quality.

A total of 2,347 bushels of peaches were handled by these stores during the period of the study, of which 944 bushels were sold by the bushel, 892 bushels were sold by the pound, and 511 bushels were lost through waste.

DEGREE OF SOFTNESS

The degree of ripeness as measured by softness was the most important factor in peach quality affecting volume of sales (Fig. 1). In the study, all peach displays were classified into the three groups: hard, medium hard, and soft or ready-to-eat peaches. The ready-to-eat peaches sold twice as rapidly as hard peaches. Of the total of 176 peach displays observed, 12 percent were classed as being mostly of hard peaches, 43 percent as medium hard peaches, and 45 percent as ready-to-eat peaches. This indicates that over half the peaches offered for sale were greener than liked by the average customer.

Displays were generally of peaches of more than one degree of firmness. If each display had been entirely of the same degree of firmness, the differences in sales of fruit of different degrees of firmness would probably have been greater than actually found.

Several changes occurred in the appearance of the displayed peaches as they became softer. The more desirable ones from the

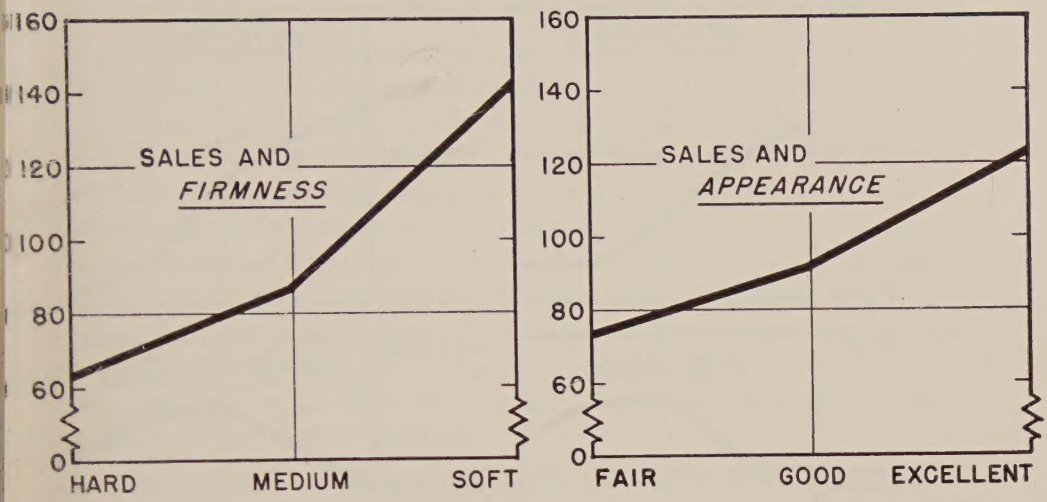

Fig. 1. The effect of appearance and firmness on volume of pound peach sales.

The degree of firmness or softness was more important than appearance in influencing the rate of peach sales. The rate of sales increased much more between medium and ready-to-eat peaches than between hard and medium peaches. The increase in sales due to appearance was at nearly a constant rate for fruit ranging from "fair" to "excellent" in appearance.

viewpoint of ripeness, lost some of their brightness and developed an increasing percentage of bruises and rots (Fig. 2). At the same time, the shade of green color changed from dark green to a lighter, or yellow green. This change in color caused customers to inspect the fruit more closely. Where the peaches were obviously green in color, most customers did not bother even to stop to inspect them. In instances where peaches were of a yellow green color and still very hard, the customer stopped, felt the peaches and then usually passed on. Peaches were thus forced to pass at least two tests before they were actually purchased by the customer.

APPEARANCE

The appearance of the fruit itself, without reference to method of display, was a major factor affecting sale. This estimate of appearance was based on the overall impression of the peaches as the enumerator or customer looked at them, so that color, brightness, rots, bruises, and other characteristics affected the rating. Peaches with "excellent" appearance sold almost twice as rapidly as those with "fair" appearance and those with "good" appearance sold at a rate midway between "fair" and "excellent" peaches (Fig. 1).

Of the lots rated, 11 percent were rated as "excellent" in appear-

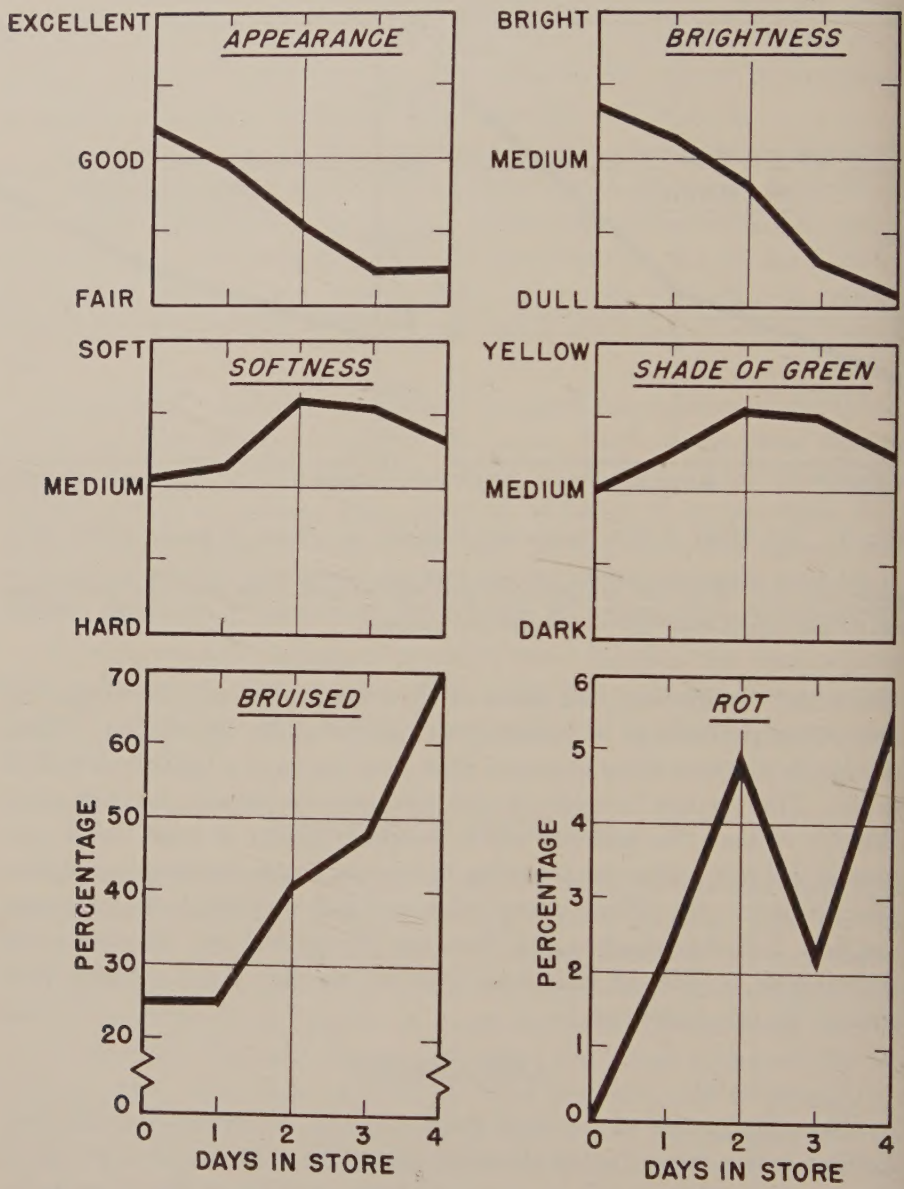

Fig. 2. Appearance and quality factors as affected by the days that peaches were held in retail stores.

General appearance and brightness declined steadily for about 3 days, during which time they declined a full class from "excellent" to "medium" or "medium" to "fair". Softness increased and the shade of green became more yellow for 2 full days after the peaches were brought to the store. After this the peaches apparently changed at such a slow rate that the purchase of the softer and more yellow ones more than balanced the rate of ripening and the less desirable ones were left. Bruising increased from one-fourth of peaches with a noticeable bruise when they were first put on display to almost three-fourths at 4 days. The percentage of peaches on display showing rot rose from none to about 5 percent at 4 days. The practice of sorting for rot every third day accounted for the decrease noted on the third day.

ance, 57 percent as "good", and 32 percent as "fair". Several factors contributed to the general appearance rating. One was the brightness or freshness of the fruit. Dull peaches never rated "excellent" in appearance. On the other hand, some very bright peaches were rated "excellent" in appearance even though they showed only a small amount of red coloring. The percentage of red coloring was an unimportant factor in appearance, as rated by the enumerator, except for unripe peaches. The larger sized peaches were rated as having slightly better appearance than the small ones. Rots and bruises detracted from the appearance of many lots. None of these appearance factors individually was found to have a significant effect on sales. However, they had an indirect effect due to their influence on the general appearance and other visible qualities.

Some stores over-ordered, especially during the period when bushel sales were being pushed. This resulted in an excessive carryover of peaches, with resultant deterioration in appearance. The carryover of sufficient stock to assure sufficient ripe peaches to meet the demand was found to be a common and desirable store practice.

Despite the fact that appearance as appraised in this study deteriorated constantly while the peaches remained in the store, the fruit's customer appeal, which included the quality factor appraised by feeling the fruit, increased during the time required for ripening. Overripe peaches were, of course, rejected by the customer because of attendant bruises.

A major difficulty faced by the retail merchant who buys peaches is that of determining whether hard peaches of good appearance will ripen into soft peaches of good appearance.

WASTE

A total of 511 bushels or 22 percent of the peaches handled by the stores were lost because of rots, bruises, and other defects. Loss or waste in the store results from practices to which each participant in the marketing process contributes.

At the time the peaches were brought into the stores, they were almost entirely free from visible rot, although varying amounts of rot infection were present. The practice of buying green peaches and bringing them to the store for ripening has evidently been found by experience to reduce waste. Practical methods of buying ripe peaches have not been developed.

Over-ordering was a major cause of waste in some stores. This was particularly bad in 1948 because of a marked decrease in demand for bushel peaches for canning, compared with 1947. It was not possible to determine what part of this decrease was due to the quality and price of the peaches and that due to other factors such as the availability of the commercially canned product. Retailers have no way of knowing in advance of such changes in demand.

Another cause of high waste to the retailer was the practice, in some instances, of waiting from two to three days after the peaches were delivered before the rotten peaches were sorted out. Tests have shown that as many as half of the "rots" under such conditions may have been due to the spread of infection from contact with rotting peaches.

Another cause of waste in self-service stores was that of handling of the fruit by the customers. Observations of over 100 customers during this study show that the average customer handled more than two peaches for every one purchased. The greener the peaches, the more they were handled in the search for soft ones. Bruising increased rapidly after peaches were put on display (Fig. 2). This increase in bruising was caused, to a large extent, by customers' handling, although some of it was due to rough handling by clerks.

Mechanically refrigerated cases were used for part of the peach display in four of the stores. These cases reduced rot, but they seemed to increase shriveling and deterioration in quality.

PRICES AND SALES

The retail price of the peaches was not related to their quality as measured by the enumerator. Even so, the retail price had an important effect on the volume of retail peach sales by the pound (Fig. 3). A decrease in the retail price of soft peaches from 10 to 6 cents per pound, increased sales by one-sixth. A similar decrease in the price of hard or not-ready-to-eat peaches resulted in an increase in sales of about one and one-half times. This increase was almost 10 times that noted for the soft peaches at a corresponding reduction in price.

The reaction of customers to the price of hard and of ready-to-eat peaches suggests the need for a different price policy for the two. This policy would aim at increasing the sales of hard peaches. Since a reduction in price increased the sales of peaches that were not-ready-to-eat, the retailer could increase sales and reduce losses by offering

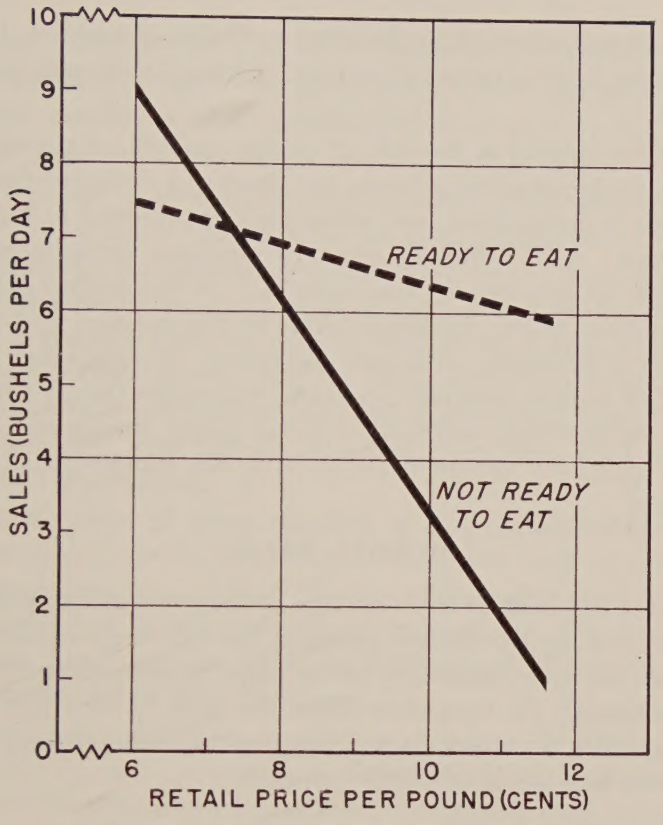

Fig. 3. The effect of retail price on the volume of pound sales of ready-to-eat and not-ready-to-eat peaches.

Variations in retail prices from 6 to 11.6 cents per pound had much less effect on the rate of sale of ready-to-eat peaches than on those of not-ready-to-eat peaches.

these peaches at reduced prices. For the ready-to-eat peaches, where price apparently had less effect on sales, he could increase the price somewhat. The average price for the two types of peaches need be no higher than at present and could possibly be lower since a certain amount of waste should be eliminated. The present policy of charging the same price for both ready-to-eat and not-ready-to-eat peaches discourages sales of the latter and has little effect on the sales of the soft peaches. The lower price for the greener peaches should be good business to the extent that it would reduce the present waste. The higher prices for ready-to-eat peaches would be justified to the extent that holding the peaches for ripening entails greater waste. Such a price policy is contrary to the present policy of many chain stores, and

is not considered practical by them for a number of reasons. However, it would seem to offer means of increasing fresh peach sales and reducing waste.

There are dangers in the sale of unripe peaches, of course. In the first place, unripe peaches often do not ripen to a desirable quality and flavor. This is particularly true when they are ripened at refrigerator temperatures. A 70° - 80° F. room temperature apparently gives a much higher quality peach upon ripening.[3] In the second place, some of the loss from waste, formerly taken by the retailer, will be transferred to the consumer. This may discourage the consumer in future purchases of unripe peaches, especially where the peaches rot before ripening. In the third place, there is the slight chance that a housewife may purchase unripe peaches with the thought that they are ready-to-eat.

BUSHEL SALES

A total of 944 bushels or 40 percent of the peaches handled in these stores were sold by the bushel, primarily for canning purposes. In this type of sale the price seemed to be the major factor influencing volume of sales, although the customers chose the riper baskets first. Most of the bushel sales occurred during the peak shipping season of about two and one-half weeks of the five studied.

DISCUSSION

It is recognized in the analysis that the 1948 season was not a good one as far as sale of peaches was concerned. Canning was very much less than during the previous year and the prevalence of brown rot and other rots was quite marked. Sales of peaches in Detroit, as a result, were much below those for the previous season.

An analysis of the sales data indicated that sales increased as the peaches became softer. Sales also increased as the appearance improved. The rate of sales of peaches with "excellent" appearance were double those of peaches with "fair" appearance. The rate of sales of "soft" or ready-to-eat peaches were double those of "hard" peaches. If we take the worst possible combination, that is, "green" peaches only of "fair" appearance and compare them with "soft" peaches of "excellent" appearance, we find that sales increased by about six times between these two classes of peaches. Any policy which would allow

[3]Paul, Pauline, and Cravens, M. E., Jr. Storage of Peaches of Different Degrees of Ripeness. Mich. Agr. Exp. Sta. Quart. Bul. 31(4) (May, 1949): 402-405.

the offering of these riper and better appearing peaches to the retail stores should increase turn-over and reduce waste. The practical question is—how can this be done? Another practical question to the retailer and others is whether the added cost of practices that would greatly increase the rate of peach sales would either cause such an increase in the retail price or a reduction in the retail spread that they would be unprofitable. For instance, can he afford to pay enough more for firm ripe peaches over green ones to induce the grower to market them? It is possible that the risk involved to the farmer in harvesting and marketing riper peaches may be too great for him to do it without a very considerable increase in the price that he would have to get for the riper peaches. This higher cost might more than offset the advantages of the riper peaches.

The retail waste of about one-fifth of all peaches handled for the five weeks' period was so large that it could only have meant a loss to some of these stores in handling peaches. This waste varied from store to store depending on the individual store manager. The lowest waste of any store was 6 percent, while the highest was 27 percent. Several factors contributed to this difference.

Retailers frequently over-ordered on peaches. In large part, this over-ordering or over-optimism was based on the volume of sales during the previous year when bushel sales for canning were much higher. Two unfavorable effects resulted from this over-ordering in 1948. One was that peach appearance declined steadily as peaches aged in the stores causing a reduction in sales. The other was that waste increased in proportion to this over-ordering. While it is not possible to order correctly in a perishable product each day, it is desirable to order as correctly as possible. This factor of over-ordering was one of the two major ways in which differences in waste between stores could be explained.

Another factor that varied among stores and contributed to the difference in waste among stores was the policy with respect to sorting out rotten peaches before they had time to infect others through contact with them. Frequent and thorough sorting out of the rots reduced waste.

An analysis of peach prices in these stores indicated that visible variations in peach quality (including firmness) resulted in variations in the volume of sales rather than in the price of the peaches. This was opposite to the effect of observed quality on the price of peaches in

the Benton Harbor market.[4] While this same relationship of quality, price and volume of sales is probably true in other perishable products, it should be an advantage to the retailer to price the products more in line with the consumer's judgment of quality. This would involve a premium on ripe peaches with good appearance and a discount on peaches that were green or lacking good appearance. Practical considerations in the management of these stores prevent such a policy at present. Their attempts to eliminate this difference have been mostly in the field of buying a standardized good quality product. The policy of differential pricing in the individual retail stores has not been successful where it has been tried in chain stores.

The peaches observed in the stores were all marked U. S. No. 1 and were thought to be of similar quality at the time they left the shipping point. However, wide differences were observed at the retail end 2 to 5 days later. For instance, some lots were observed to rot more quickly than others in the same store. Others never reached the desirable yellow-green soft stage of desirable ripe peaches. These are but two of the variations in quality that are due to factors at the growing and shipping end. Since the retailer has nothing to do with the growing, grading, or packing of the peaches, most of the quality variations are not his fault. However, as a buyer, he must judge them from what he can see at the wholesale market. Errors in buying are mostly due to inadequate standards and information concerning the factors in peach quality. Peaches with a tendency to rot may seem just as good at the shipping point as others practically free from this tendency. Immature peaches may sometimes seem to be as large and as good as mature ones even as to the shade of green. Under such circumstances, the daily purchase and retail sale of a uniformly high quality peaches is very difficult. In order to improve this situation, accurate data are needed on *what* goes on within a peach and the reason for the changes, from the time the peach leaves the tree or before until it reaches the consumer some days later. In view of the perishability and lack of standardization of the product and the great amount of guess work concerning quality that is involved in peach marketing, these stores did a very commendable job in selling peaches. With more information regarding peach quality control and the control of rot, they could do an even better job in selling them.

Further information is needed on peach carrying quality with

[4]Hathaway, D. E., and Cravens, M. E., Jr. Quality Factors Affecting the Price of Peaches on the Benton Harbor Market. Journ. of Farm Econ., XXXI(1) (Feb., 1949).

different degrees of ripeness, on the control of rot and the various practices that affect quality factors. More information is also needed on the means by which peaches can be marketed with greater standardization of quality. This additional information will aid in the reduction of the waste in peach marketing. It should also increase the desirability of peaches and the consequent demand for them.

CONSUMER RESPONSE TO PREPACKAGED FRESH MEATS

By ROBERT C. KRAMER
SECTION OF AGRICULTURAL ECONOMICS

NEW FACILITIES for retailing fresh meat are being introduced each day in some part of the United States. One of the most recently introduced ways of merchandising fresh meat is the 100-percent self-service method.[1] Seventeen stores in Michigan were using this innovation on April 1, 1949 (1). Another dozen or more stores will probably follow suit by the end of 1949. This article gives a brief history of 100-percent self-service for meats and the results of a survey of shoppers of one Michigan store who have used this new method when buying their meat supplies.

This new method was actually introduced in a very limited manner in 1942. Gilchrist (2) indicated that merchants in the Los Angeles area were the first to use it and they began in 1942 when the last war caused a shortage of labor. Open-top refrigerated cases were not available during the war, so an expansion of self-serving meat was not possible. Gilchrist also estimated that only 25 retail meat departments were completely converted to self-service in the United States by the summer of 1946. In 1947 self-service refrigerated cases became available again and many merchants began converting. This conversion is now spreading rapidly across the United States.

Teitelman (1) best described this rapid expansion. He said that as of April 1, 1948, there were 178 meat stores that were 100 percent self-service. On April 1, 1949, there were 878 such stores. He also estimated that by the end of 1949 approximately 1,500 meat stores in the United States would be completely converted to self-service. This means that more than two meat stores each day will be converting to complete self-service.

[1]Retailers using 100-percent self-service operate their meat departments as follows. Carcasses and wholesale cuts are delivered to the store as usual. In the store the meats are cut into retail cuts (steaks, chops, roasts, etc.), then the employees wrap, heat-seal, weigh, price, and display these cellophane-wrapped packages of meat in open-top refrigerated meat cases. Shoppers select their particular meats from these meat cases and do not have to talk with the butcher or his helpers.

ARTICLE 32-2

Besides the 100-percent self-service stores there are many meat departments which may be considered partial self-service. These meat departments offer some meat items on a self-service basis but still sell some meat over the counter. Teitelman said there were about 5,000 stores on a partial self-service meat basis in April, 1948, that there were 7,700 in April, 1949, and that this number, too, would continue to grow.

Complete or 100-percent self-service of meats seems to be here to stay. It is no passing fancy. The results of one survey—part of a research project this writer is conducting—are presented here.

PROCEDURE

Any revolutionary innovation in the food business must be accepted by consumers before it becomes a profitable practice. To determine what consumers thought about 100-percent self-service, questionnaires were passed out to shoppers in a super market which had converted to complete self-service of meats 5 months previously. All shoppers were given the questionnaire as they checked out at the cash registers. Both those buying as well as those not buying meats received the questionnaire. One object was to find out what these consumers liked and disliked about self-service meats. Three hundred and thirty questionnaires were returned.

RESULTS

It was mentioned earlier that the customers must be pleased. It was believed before the survey was run that women do most of the meat buying. A question was asked to determine if this belief were true. Table 1 shows the results of this question.

Answers to this question indicate that the homemaker does most of the meat buying and if she is not satisfied with prepackaged meat,

TABLE 1—*"In your family, who does most of the meat buying?"*

Replies	Number reporting	Percent
Wife or homemaker	242	73
Husband	80	24
Son	3	1
Daughter	2	1
Did not answer	3	1
Total	330	100

TABLE 2—*"Why do you like prepackaged meats?" (Check all reasons that apply)*

Reasons	Number of customers checking each reason	Percent that checked each reason
Weight and total price are given	237	72
Can shop quicker	233	70
Can examine the meat	198	60
Larger selection	118	36
No talking with butcher	61	18
Only kind sold in store	59	18
Meat is fresher	52	15
Less bone	42	13
No particular reason	28	8
Meat has higher quality	25	8
Did not answer this question	26	8

that method of retailing will not be successful. They also show that husbands are buying about one-fourth of the meat. Ester Latzke (3) said that husbands are becoming increasingly important in shopping for the family food supply.

Two other questions were: 1) "Why do you like prepackaged meats?" and 2) "Why do you not like prepackaged meat?" Ten reasons were listed under the first of these two questions and the consumers were asked to check all reasons that applied in their particular case. Also, they were asked to add comments if the 10 reasons listed did not completely cover their likes for self-service meat. The ten reasons are listed here in order of their importance (Table 2).

More than 70 percent of the respondents gave the first two reasons in Table 2 as being most important in buying prepackaged meat. In the stores selling meat over the counter the customer frequently spends more time buying meat than for all the rest of the food shopping. With meat self-served there is no waiting. Having weight and total price given on the package, the customer soon can learn if the meat cut will be large enough and if the total price fits the budget.

Being able to examine the meat was the third reason checked. Since the packages are wrapped in cellophane, the top and the sides of the package can be examined at close range. This was not possible when the butcher "held-up" a piece of meat in back of the meat case. Another significant point in this table is the number who stated that they did not have to talk with the butcher. Nearly a fifth checked this answer. Latzke (3) said that it appears that women have been intimidated by meat market men for years and now they can select their own purchases.

Here are some representative responses that were made as to why these respondents liked self-service prepackaged meat:

One can handle the meat and see what he is getting.
We have a small family. We can buy smaller quantities which the butcher does not like to cut.
Often we see cuts of meat we had not thought of.
More sanitary.
More attractive.
Time to make a choice.
No waiting in line.
I like the prepackaged plan so I can see the entire piece instead of having the clerk carefully hold it so I can see only the best-looking side and get a surprise when I get home and see what I bought.
It's the best yet for service.
The large display helps immensely when you have a family that wants variety as my family does.
It's ready to store in the refrigerator.
Less fat.
Can take your time and get a good buy. The other way you drive the butcher crazy.
It saves time.

There are two sides to each question and this statement applies to self-service meat departments. Customers were also asked what they did not like about self-service meat. These are some of their replies:

Too expensive—pieces on top look nice but underneath you sure get fooled.
Does not taste fresh enough.
I found the fat folded under on the pork chops.
I like to buy beef and then have it ground for hamburger.
I don't know how long it has been packaged.
Backing cardboard can hide excess bone and/or fat not visible on top or on sides of package.
Meat should be in a larger variety of weights per package.
I like to see the meat weighed.
I like to see both sides of what I am getting.
The packages are too flimsy—I sometimes feel that the meat might get contaminated from so much handling.
Cannot be completely sure of absolute freshness.
Has the same impersonality of an automat.
I like to have advice of the butcher if I know him.
I never feel sure of its freshness and it does get handled more.

SUMMARY

On April 1, 1949 there were about 878 meat stores that were 100-percent self-service, and it is estimated that there will be approximately 1,500 stores in the United States completely converted to 100 percent self-service by the end of 1949.

This new method of retailing fresh meat seems to be here to stay. A survey of shoppers who have used 100-percent self-service revealed that they principally liked it because the weight and total price are given, they can shop quicker, and they can examine the meat.

Several of the respondents had one or two objections which were mainly concerned about freshness, being fooled about excess fat or bone, the price being somewhat higher, and the lack of variety of different meat cuts—such as types, sizes, thicknesses, and counts. The writer has talked with several retailers who are using 100 percent self-service with meats. These retailers say that there are several technical problems yet to be solved and that they have had difficulties in anticipating the demands of their customers. They deny, however, that they are pricing packaged meat any higher than comparable meat sold over the counter. Further studies are needed on the technical and the economic problems of prepackaging both fresh and frozen meats. Frozen prepackaged meat still is of little significance.

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A NUTRIENT-ELEMENT BALANCE CHART

By A. L. KENWORTHY
SECTION OF HORTICULTURE

A NUTRIENT-ELEMENT balance chart has been designed that involves colors for the various ranges of values found in the composition of leaves. This chart involves five concentric rings and three colors. The **green ring** indicates the composition at which the plant is receiving the nutrient-elements in the desired amounts. The **inner amber** ring may be considered to represent an area of "hidden deficiency" and the **inner red** ring as visible deficiency. The **outer amber** and **outer red** rings are areas of luxury supply in excess of that required by the plant in the particular environment. If the preceding terms are applied to the **outer amber** and **outer red** rings they would then be called "hidden toxicity" and "visible toxicity" respectively. However, for many nutrient-elements a visible toxicity is not commonly expressed except through a deficiency of some other element.

The names of 10 nutrient-elements are placed around the outer edge of the chart. The 10 given on the accompanying chart are those that may be commonly purchased as fertilizers. The so-called "major" elements are alternated with the "minor" elements.

To represent the amount of each element in a given sample, a heavy black line is drawn from the center of the circle outward towards the nutrient-element being considered. It may, for example, represent the values obtained by analyzing leaves chemically, spectrographically or by some other method. If the line extends to the middle of the **green ring,** the nutrient-element is being supplied to the plant in optimum amounts as compared to the standard being used. Such standard values in leaf composition are assigned the value of 100. The nutrient-element analysis for other treatments or orchards are compared with the standard by calculating the index value for each element as compared to 100 for the standard.

The other information on the chart identifies the source according

ARTICLE 32-3

NAME _____
ADDRESS _____
SAMPLING DATE _____

NUTRIENT – ELEMENT BALANCE CHART

VARIETY _____
AGE OF TREES _____
LOCATION _____

FERTILIZER PROGRAM _____

_____

SOIL MANAGEMENT _____

_____

SPRAY MATERIALS _____

_____

DEPARTMENT OF HORTICULTURE, MICHIGAN STATE COLLEGE

to grower's name, address, date of sampling, variety, age of tree, location on farm, fertilizer program used, soil management practices, and spray materials applied. The nutrient-element balance condition as found in the growers orchard is then drawn on the chart, suggestions made on a separate form and both chart and suggestions sent to the grower. If the chart is used in connection with experimental plots the desired information is written on the chart where desired, and the treatment giving the most desired response used as a standard.

This nutrient-element balance chart has been used in a grower leaf-analysis service in Michigan. It gives the grower a quick and clear picture of the condition in his orchard. Also, this chart has been useful in interpreting leaf analyses as associated with various cultural practices.

CHICORY IMPROVEMENT IN MICHIGAN

By H. L. KOHLS
SECTION OF FARM CROPS

IN MICHIGAN during the late 'twenties 8,000 to 10,000 acres of chicory was grown annually to supply domestic consumption. Today 10,000 to 15,000 acres seem necessary to supply the same quantity. Tonnage per acre of chicory is dependent upon quality and variety of seed used, and there is some evidence that European seed some years ago was more productive than the seed of today.

The unusual yields are more likely to be remembered than the average yields. One or two 8- or 9-ton yields are more readily remembered than many years of 4- or 5-ton yields. Possibly the average acre-yield of chicory has declined in the last 20 years, but the available data are insufficient to determine any trend in the average yield of chicory in Michigan. However, a brief review of the seed situation in this state may shed some light on what may be taking place in the quality of seed that is being used by Michigan chicory growers.

Since the beginning of the chicory industry in Michigan, about 1890, until about 1940 all the chicory seed used in this state was imported from Europe, except during World War I when some seed was grown in Michigan. Several varieties were available, and a few of the better ones were satisfactory for use in this state. For several years prior to World War II it became increasingly difficult to get desirable seed from Europe. In 1937 the author started a study of methods of chicory seed production and as a result of that work Michigan began in about 1940 to produce most of its own seed.[1]

The most satisfactory lot of seed available for increase consisted of a mixture of types. There was no breeding program of any kind connected with the seed increases and no improvement could be expected by just increasing the quantity of seed.

[1]Growing Chicory Seed. By H. L. Kohls and H. C. Rather. Mich. Agri. Exp. Sta. Quart. Bul., 23 (4) (May 1941): 243-250.

ARTICLE 32-4

TABLE 1—*Data from chicory selections tested near Coleman, Michigan, in 1946 and 1948*

Selection No.	Yields		Average yields	Percent non-bolters 1948
	1946	1948		
Ac. 1 1	7.53**	15.36**	11.45	91.63**
Ac. 1 4	6.45**	12.50**	9.48	91.63**
Ac. 1 5	6.93**	11.88**	9.41	93.36**
Ac. 1 8	7.27**	14 91**	11.09	84.71
Ac. 1 10	5.72**	13.75**	9.74	87.30
Ac. 1 12	4.94	12.77**	8.86	88.17**
Ac. 1 13	4.89	12.50**	8.70	90.76**
Ac. 1 15	5.33**	12.23**	8.78	81.25
Standard	4.33	8.93	6.63	86.44

**Statistically above the standard variety at the 1 percent level.

After three or four generations of increasing without selection on our part it now appears that natural selection may be taking place. Some plants produce more seed than others and the percentage of these high seed-producing plants increases with each generation. These high seed-producing plants may not be desirable for commercial root production. If this is true chicory growers may have a good basis for their statements that chicory yields are lower than they were years ago.

In 1944 chicory breeding work to improve yields was begun in cooperation with E. B. Muller and Company. Part of the program is to make a large number of selections, isolate the selections in one group from all other flowering chicory, including wild chicory, and progeny-row test the seed from each plant selection. The data are now being presented from a few selections that produced enough seed for two years' testing. The data are shown in Table 1.

The average yield of the standard variety in 1946 was 4.33 tons per acre. This is about the average yield of the commercial fields for the years 1940 to 1947 inclusive. In 1947 the soil was so dry that the chicory seed in the variety test did not grow. The season of 1948 was exceptionally good for chicory production and the average yield of the standard variety in the test was 8.93 tons, about double the normal yields. Some of the best varieties in the more fertile parts of the field averaged over 17 tons per acre, while the standard variety in the same area yielded about 12 tons per acre. It is interesting to note that the percentage increase each selection made in 1946 was very similar to the percentage increase the same selection made over the standard in 1948 even though the seasons were quite different.

Selection 1 is a very promising strain. Not only does it lead the list in tonnage but it is also one of the highest in percentage of non-bolting plants. Non-bolting is a character that is very desirable from the processor's point of view because non-bolting plants carry less fiber in their roots to interfere with the processing of the roots for commercial use.

The data indicate that there is a great opportunity to increase chicory yields by selection and that the non-bolting character can be developed further. General observations lead one to believe that improvement may be possible with such characters as smoothness of root, type of root, resistance to some diseases, more rapid growth in the seedling stage and percentage sugar, particularly levulose. The selections reported here are being tested for some of these characters. But while the testing is going on we are also increasing the quantity of seed as fast as possible because the high yielding ability of these selections and their lack of any seriously undesirable characteristics makes them far more desirable for commercial use than the present commercial variety. The commercial use of these selections in Michigan should increase the average yield of chicory materially.

THE EFFECT OF TRUNK GIRDLING ON INDUCING EARLIER BEARING OF NORTHERN SPY APPLE TREES

By WALTER TOENJES
SECTION OF HORTICULTURE

AMONG THE MORE prominent apple varieties grown commercially in Michigan the Northern Spy holds an important place. This popular variety was already included in some of the earlier orchard plantings of nearly 100 years ago. The large size and high quality fruit of Northern Spy, for both fresh use or for cooking purposes, have created a good demand for it on the market. This demand has encouraged Michigan growers to plant increased numbers of trees of this variety in their orchards during the past 40 years.

However, from the grower's viewpoint, this variety has several undesirable characteristics. When grown on the heavier and more fertile types of soil, and under good cultural and fertilizer practices, it has shown some susceptibility to crown injury, usually occurring about the time that the trees come into bearing. Also, the trees have a decided tendency to form narrow crotches, which often cause them to break down under the stress of heavy crops. Further, the variety is biennial in bearing habit. Another fault, probably the one most important to the commercial apple grower, is that the variety is slow to come into profitable production. In some instances growers have not obtained a crop of fruit before the trees were 18 years old; in most instances trees come into bearing when they are from 12 to 15 years old.

Previous experiments have shown that certain artificial practices can be employed to induce earlier bearing with the apple. The practices most commonly used are trunk-girdling, ringing, scoring, and notching. They are designed to interfere temporarily with the normal downward movement of carbohydrates in the bark. When this movement of carbohydrates is stopped briefly during the active growing

ARTICLE 32-5

TABLE 1—*Yield response of Northern Spy trees trunk girdled in their eight, ninth, and eleventh growing years*

Treatment	No. of trees	Growing year with bushels per acre											
		Ninth year	Tenth year	Eleventh year	Total	No of trees	Twelfth year	Thirteenth year	Fourteenth year	Total for 12th to 14th years incl.		Total for 9th to 14th years incl.	
										% Increase	Increase	% Increase	Increase
Girdled	*12	170.0	29.0	4.5	203.5	**12	459.0	6.0	823.0	1288.0	16.8	1492.0	34.8
Check	12	0.	1.6	2.1	3.7	12	89.	389.	625.	1103.	—	1107.	—
Girdled	—	—	—	—	—	**48	401.	18.	762.	1181.	18.5	—	—
Check	—	—	—	—	—	46	98.	260.	639.	997.	—	—	—

*Trunk-girdled in their eighth and ninth growing year.
**Trunk-girdled in their eleventh growing year.

period of the tree, which corresponds roughly to the period of normal fruit-bud formation, a build-up of carbohydrates occurs in those parts above the point of girdling. This brings about a condition that encourages the formation of fruit or blossom buds from those buds that heretofore were only vegetative in nature. This formation of blossom buds then places the tree in a favorable position to produce a crop of fruit the season following.

To determine the effect of girdling upon early bearing of Northern Spy trees, 12 young, non-bearing trees were girdled on May 25, during their eighth year in the orchard. An equal number of trees, alternating in the same row, were left untreated as checks. The girdling was accomplished by removing a strip of bark, one-eighth inch in width, cut to the depth of the wood and completely encircling the trunk, at a height of 12 inches above the ground line. The girdling wounds were immediately covered with a protective coating of a non-injurious grafting compound to prevent both the drying out of the exposed tissue and the possible entry of disease organisms. The operation was repeated in the ninth and eleventh growing years.

The production of fruit resulting from girdling Northern Spy trees is shown in Table 1.

The trees girdled in their eighth year produced a light-to-moderate set of blossoms the following spring, while no blossoms were produced on the ungirdled trees. At harvest time the girdled trees yielded an average of 66 pounds of fruit, or a total of 170 bushels per acre, based on the tree spacing in this orchard of 20 x 20 feet, or 108 trees.

Following the repeated girdling of the same trees in their ninth year, only a light set of blossoms appeared in the spring of the tenth year. The effect of this second girdling was much less pronounced than that resulting from the first girdling, and which is indirectly reflected by the smaller yield of 29 bushels per acre. In the eleventh year the set of blossom buds and fruit yield on the previously twice-girdled trees was negligible, indicating that the effect of girdling was only temporary and did not induce the young trees to come into regular bearing.

In view of this behavior, the same 12 trees and an additional 48 trees were girdled on June 18, in their eleventh growing year, and 46 trees were added to the group of check trees. Figure 1 shows the amount of bloom present the spring following, on both the girdled and ungirdled trees. The resulting yields for the original 12 trees in each treatment amounted to 459 bushels per acre for the girdled and

Fig. 1. Northern Spy trees in their twelfth growing year showing the heavy bloom on alternate trees trunk-girdled in their eleventh growing year, and the light bloom on the alternate ungirdled trees. Barrels seen between trees contain blossom boquets for cross-pollination.

89 for the ungirdled. The additional 48 trees girdled in their eleventh growing year yielded 401 bushels per acre the year following as against 98 bushels for the ungirdled trees. Having produced a good crop in their twelfth growing year, all girdled trees yielded only a few fruits in their thirteenth year, but came back with a heavier crop in their fourteenth year. In contrast, the ungirdled trees showed progressively increased yields starting in their twelfth year, with yields nearly equaling that of the girdled trees in their fourteenth year. This indicates the ungirdled trees had reached the age when Northern Spy normally begins to bear regularly.

In summarizing the yields of the girdled and ungirdled trees in the 12-tree groups, the calculated acre yield for the former amounted to 203.5 bushels, and 3.7 bushels for the latter in the ninth, tenth, and eleventh years. Following the repeated girdling in the eleventh year, the girdled trees yielded a total of 1,288 bushels per acre during the next 3 years, while the ungirdled trees produced 1,103 bushels per acre during the same period, an increase of 16.8 percent in favor of the former. Totaling the yield for all the years covered by this experiment the 12 ungirdled trees produced an accumulated total of 1,107 bushels, and the 12 girdled trees 1,492 bushels per acre, an increase of 385 bushels or approximately 35 percent in favor of the latter.

The total yield of the 48 trees girdled in their eleventh growing year amounted to 1,181 bushels per acre for the following 3 years, an

increase of 18.5 percent over the 997 bushels produced during the same period by the corresponding ungirdled trees.

These results show that Northern Spy trees can be induced to bear at an earlier than normal age by girdling of the trunk prior to the period of fruit bud formation. Also, when girdled at the early age of 8 years the trees produced a fair crop the following year, but the early girdling failed to start them into regular bearing. This tendency to regular bearing was not brought about until after they were girdled in the eleventh growing year. This would indicate that the closer to their normal bearing age the girdling is done, the more likely it will be successful in bringing them into regular bearing. Further, the increased yields of the girdled trees by the end of the fourteenth year was sufficient to more than off-set the cost of girdling and, therefore, was profitable.

No injury to the trees resulted from the girdling operation. The narrow wound made by the removal of a one-eighth strip of bark healed over readily, whereas a much wider wound would require a longer period and may possibly cause injury by failing to heal over properly. When this occurs, bridge-grafts should be placed the following spring to span over the unhealed area. If successfully done this will prevent any permanent injury to the tree.

TYPE AND VARIABILITY IN BUD MUTATIONS OF THE CHERRY AND APPLE

By V. R. GARDNER

Stocks of vegetatively-propagated plant varieties are influenced by environment in much the same way as those of seminally-propagated varieties. They grow more or less vigorously, flower and fruit more or less abundantly and otherwise thrive or fail to do so, depending on conditions. It has been generally assumed, however, that because all the individuals of a variety are genetically alike they will be characterized by a greater degree of uniformity, a closer approach to type, than are the individuals of varieties propagated by means of seeds. Nevertheless quantitative data that answer this question are not available, for in extremely few instances do we have both vegetatively- and seminally-propagated varieties of the same *kind* of plant, e.g. apple, asparagus, or azalea. It is hardly fair, therefore, to compare type and variability in, say, the Bartlett pear which is propagated by means of graftage with that of the cocoanut which is seed-propagated.

A variety of a seed-propagated plant originates as, and is developed from, a single seedling, whether it may have mixed parentage or may appear as a mutation in a relatively uniform strain of a variety that represents a long line of close breeding. It is a general practice to grow it for a period of years during which more or less rigid selection is employed in an attempt to reduce variability and "fix" type. This is not the procedure with bud-propagated varieties. They may originate as single seedlings, just as do the seed-propagated forms, or as bud mutations, but in either case, when once the decision is made to propagate and introduce them, no selection is employed. They are assumed not to be variable, at least in the sense of the seed-propagated kinds, and no "fixing" is required. It has been repeatedly observed that in reality these clonal varieties show considerable variation but quantitative or statistical data on its magnitude are all but non-existent.

In a series of studies at the Michigan Station, the author and some

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of his associates have presented some tabular data on intra-varietal diversity in one variety of apple[1] and one pelargonium.[2] The records do not, however, lend themselves to a determination of certain statistical means of comparison, such as standard deviations or coefficients of variability, with either comparable seed-propagated forms or parent bud-propagated clones.

OBJECTIVES, MATERIALS AND METHODS

Careful observation of original limb sports of several tree fruits and of trees propagated directly from them during the 1922-45 period lead the writer to believe that many, if not most, such sports are not uniform, not stable. Indeed, many seemed to present as much diversity

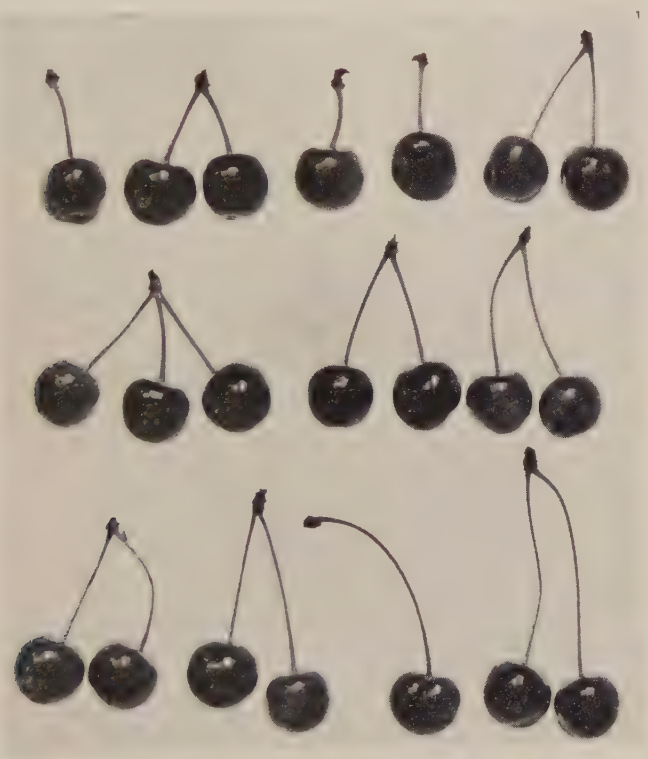

Fig. 1. The fruits in the top row are normal Montmorency (Selection 394B). Those in the bottom row are one of its long-stemmed bud mutations (Selection 394); note the greater variability in stem length, as compared with the normal. Fruits in the center row are from another mutating limb in the same tree, more or less intermediate in character between the normal and the long-stemmed form.

as many seedling stocks resulting from crossed parentage. "Fixing" by means of selection seemed to be as much of a requisite in the one instance as in the other. In view of the fact that the materials were available, it was decided to obtain suitable records of certain characters from which both type and variability could be accurately determined.

TABLE 1—*Frequency distribution tables for stem length for the 1935 crops of certain parent Montmorency cherry trees and their short-stemmed or long-stemmed limb mutations*

Tree number	481		482		624		623		609		608		771		772		200		163	
Stem length in inches	P*		LM**		P*		LM**		P*		LM**		P*		LM**		P*		LM**	
.3			1																1	
.4			5																	
.5	1		5		1												4			
.6	1		39														28			
.7	17		112		3												52		1	
.8	48		188		28				1				3				124			
.9	126		226		175		3		1				4				202		2	
1.0	278		242		445		4		12				22				299		8	
1.1	220		227		356		5		27		1		94		3		243		8	
1.2	206		148		260		23		61		2		127		3		177		20	
1.3	123		118		135		56		110		2		210		9		102		20	
1.4	63		75		48		94		126		3		208		12		45		29	
1.5	23		45		22		120		98		4		111		19		33		48	
1.6	13		28		10		233		80		20		53		27		8		52	
1.7	3		12		6		295		40		12		15		25		1		64	
1.8	4		6				301		25		24		4		34		2		60	
1.9			1		1		271		8		15		1		28		1		48	
2.0			3				237		5		27		4		23		3		59	
2.1			2				122		5		17				20				56	
2.2							53		1		23				6				54	
2.3							32		1		16				3				51	
2.4							16				18				1				42	
2.5							1				19				2				25	
2.6							3				13								21	
2.7							1				7								12	
2.8							1				10								9	
2.9											12								8	
3.0											8								1	
3.1											6								2	
3.2											3									
3.3											1									
3.4											3									
3.5											2									
3.6											2									
3.7											1									
3.8											1									
3.9																				
4.0																				
Total	1126		1483		1490		1871		601		272		856		215		1324		701	
Mean	1.17±	.0038	1.04±	.0044	1.1±	.0027	1.8±	.0039	1.4±	.0061	2.2±	.0213	1.23±	.0039	1.67±	.0124	1.04±	.0039	1.9±	.0107
S.D.	.1939±	.0027	.2574±	.0031	.1532±	.0019	.2506±	.0028	.2214±	.0043	.5226±	.0151	.1689±	.0028	.2690±	.0088	.2070±	.0027	.4310±	.0075
C.V.	.1567±	.0023	.2446±	.0029	.1393±	.0018	.1388±	.0016	.1581±	.0031	.2375±	.0068	.1373±	.0022	.1600±	.0052	.1990±	.0026	.2268±	.0040
t***	23.7				.2				10.6				4.1				5.8			

*Parent form

**Limb mutation

***"t" test for significance of difference in coefficient of variability. Formula: $\sqrt{\frac{C.V.1 - C.V.2}{(P.E.1)^2 + (P.E.2)^2}}$ A figure of 3 or above indicates significance at the 5% level.

PRESENTATION OF DATA

Among the features of the cherry and apple mutations for which records could be readily obtained and for which various measures of type and variability could be determined were: weight of fruit, length of stem. Form indices and ripening season could not be measured with quite the same degree of accuracy. Nevertheless their measurements in some instances were regarded as accurate enough to obtain reliable data on type and variability.

LENGTH OF STEM IN CHERRIES

In the course of the studies of bud mutations made at the Michigan Station one short-stemmed and a number of long-stemmed limb and whole-tree variants were found and several were propagated. (See Fig. 1). Usually the long fruit stems were associated with relatively long internodes, a willowy type of shoot and branch growth and comparatively long and narrow leaves. Table 1 presents frequency distribution tables for stem length for the 1935 crop borne by certain of

Fig. 2. On the left, normal-shaped Montmorency cherries from the main part of the tree (No. 351); on the right, cordate-shaped fruits from its limb mutation (No. 350).

TABLE 2—*Summarized data on type and variability in stem length for a number of Montmorency cherry mutations, together with their parent forms*

Selection number	Year	Number fruits	Mean	Standard deviation	Coefficient of variability	"t" test for significance
200 P	1933	754	1.12 ± .0051	.2130 ± .0037	.1902 ± .0033	
163 L	1933	113	2.25 ± .0357	.5620 ± .0253	.2498 ± .0113	5.1
200 P	1934	6,246	1.04 ± .0010	.157 ± .0010	.1509 ± .0009	
163 L	1934	5,468	1.81 ± .0020	.2524 ± .0015	.1394 ± .0009	8.8
200 P(D)	1936	10,841	1.083 ± .0009	.1487 ± .0006	.1373 ± .0006	
163 LM(D)	1936	1,077	1.658 ± .0110	.5227 ± .0760	.3153 ± .0047	37.9
200 P(D)	1937	12,197	1.2492 ± .0010	.1780 ± .0007	.1425 ± .0006	
163 LM(D)	1937	7,547	1.9523 ± .0026	.3306 ± .0018	.1693 ± .0009	23.5
200 P(D)	1939	4,491	1.2080 ± .0017	.1660 ± .0012	.1374 ± .0009	
163 LM(D)	1939	9,784	1.8080 ± .0036	.5180 ± .0022	.2865 ± .0013	93.2
624 P	1934	198	.980 ± .007	.1460 ± .005	.1501 ± .0051	1.5
623 LM	1934	182	1.850 ± .063	.256 ± .009	.1384 ± .0048	
624 P	1937	119	1.098 ± .0075	.1208 ± .0053	.1100 ± .0048	
623 LM	1937	211	1.910 ± .0090	.1930 ± .0063	.1010 ± .0033	1.6
771 P	1937	1,888	.962 ± .002	.1294 ± .002	.1345 ± .0015	
772 LM	1937	742	1.477 ± .005	.211 ± .004	.1428 ± .0037	2.1
771 P	1939	4,303	1.151 ± .0018	.170 ± .0012	.1477 ± .0011	
772 LM	1939	3,170	1.670 ± .0026	.213 ± .0018	.1275 ± .0011	12.6
830 P	1936	2,965	1.111 ± .003	.167 ± .002	.1503 ± .0013	
831 LM	1936	2,732	1.290 ± .003	.243 ± .002	.1884 ± .0017	18.1
797 P	1935	515	.89 ± .006	.208 ± .004	.2337 ± .0049	
796 LM	1935	320	1.117 ± .011	.282 ± .007	.2525 ± .0101	1.7
667 P	1935	863	2.3000 ± .0080	.3435 ± .0056	.1494 ± .0036	
667 P	1937	757	2.098 ± .0072	.2921 ± .0051	.1392 ± .0024	
667 D	1939	911	1.9903 ± .0080	.3585 ± .0057	.1800 ± .0028	*
667 D	1940	9,608	1.728 ± .0026	.382 ± .0019	.2211 ± .0016	
362 P(D)	1935	158	1.270 ± .0106	.188 ± .0075	.1480 ± .0059	
361 L(D)	1935	141	1.867 ± .0110	.200 ± .008	.1071 ± .0042	5.7
362 P(D)	1940	2,791	1.295 ± .0024	.191 ± .0017	.1475 ± .0013	
361 LM(D)	1940	952	2.164 ± .0052	.242 ± .0038	.1118 ± .0017	17.0
481 P	1934	191	1.04 ± .0072	.146 ± .0051	.1404 ± .0049	
482 LM	1934	312	.79 ± .0063	.166 ± .0045	.2101 ± .0057	9.3
481 P	1936	3,528	1.087 ± .0016	.140 ± .001	.1288 ± .0010	
482 LM	1936	4,466	.908 ± .002	.185 ± .001	.2038 ± .0014	44.1
481 P	1937	1,191	1.119 ± .003	.170 ± .002	.1502 ± .0021	
482 LM	1937	1,779	.813 ± .003	.184 ± .002	.2263 ± .0026	23.1
481 P(D)	1939	1,432	1.127 ± .003	.167 ± .002	.1482 ± .0019	
482 LM(D)	1939	290	.763 ± .007	.163 ± .005	.2136 ± .0060	10.4
481 P(D)	1940	5,432	1.306 ± .0016	.179 ± .0012	.1371 ± .0009	
482 LM(D)	1940	2,896	.798 ± .0022	.175 ± .0016	.2193 ± .0020	37.4
394B P	1937	1,147	1.2923 ± .0037	.1861 ± .0026	.1440 ± .0020	
394 P	1937	1,012	2.0594 ± .0067	.3180 ± .0067	.1585 ± .0034	3.7
394 D	1937	3,605	1.5553 ± .0042	.3759 ± .0030	.2346 ± .0019	&32.4
394B D	1939	1,548	1.3200 ± .0030	.1800 ± .0020	.1364 ± .0016	10.7
394 D	1939	2,266	1.8110 ± .0040	.2900 ± .0030	.1605 ± .0016	
394B D	1940	3,953	1.4040 ± .0025	.2280 ± .0017	.1624 ± .0012	20.3
394 D	1940	10,854	1.8300 ± .0023	.3530 ± .0016	.1929 ± .0009	

*"t" test for significance not calculated since the records for the parent and daughter trees of this long stemmed mutation are for different seasons. It will be noted, however, that their coefficients of variability are relatively high.

these parent trees and their short-stemmed or long-stemmed limb mutations. Table 2 presents the means, standard deviations and coefficients of variability for the stem length measurements of the same and other parent forms, together with their mutating forms for other seasons for which measurements are available.

In every instance there was a marked statistically-significant difference in type (as measured by mean and its standard deviation) between the long- or short-stemmed variant and its parent form. Variability (as measured by the coefficient of variability and its standard deviation) was greater in the short- or long-stemmed variant than in their parent forms in five of the eight instances in which comparisons were possible and this greater variability was in evidence season after season. Furthermore this difference in variability was highly significant, as measured by the "t" test in every case. On the other hand in 2 long-stemmed sports there was no significant difference between parent and sport in variability in stem length while in one instance the long-stemmed sport was significantly more uniform than its parent form in this respect.

SIZE OF FRUIT IN CHERRIES

Selection No. 482 was not only a short-stemmed form but it was also smaller fruited and earlier ripening than the parent form, and individual fruit weights of fairly large random samples were obtained for the crops borne by both the parent and daughter trees for several seasons. Table 3 presents the means, standard deviations and coefficients of variability for the individual fruit weights of the normal-sized Selection No. 481 and its small-fruited limb mutation for each of several seasons. Other size variants were found in the Montmorency cherry, but none so clear cut and distinct; therefore type and variability records are presented for this one strain only.

SHAPE OF FRUIT IN CHERRIES

Small, though noticeable, variations in shape of fruit are rather common in the Montmorency cherry. Occasionally a very pronounced variation in shape is met with. One such mutation was noted as a limb sport in a tree in western Michigan in 1928 (Fig. 2). The fruits were distinctly cordate in shape as compared with the globose or slightly oblate normal shape. Trees propagated from both the limb sport and parent tree were grown at the Graham Horticultural Experiment Station. Form indices $\left(\frac{\text{axial diameter}}{\text{transverse diameter}}\right)$ were obtained for

TABLE 3—*Summarized data on type and variability in weight of fruit of Montmorency Selections 481 and 482—parent and its small-fruited limb mutation*

Selection number	Year	Number fruits	Mean weight, grams	Standard deviation	Coefficient of variability	"t" test for significance
481 P	1935	1,126	3.8064 ± .0120	.6018 ± .0085	.1581 ± .0022	
482 LM	1935	1,483	2.8847 ±	.6739 ± .0084	.2332 ± .0029	20.9
481 P	1936	3,528	2.378 ± .005	.451 ± .004	.1900 ± .0014	
482 LM	1936	4,466	1.695 ± .003	.287 ± .002	.1693 ± .0011	11.5
481 P	1937	1,191	3.838 ± .012	.608 ± .008	.1584 ± .0022	
482 LM	1937	1,779	2.834 ± .010	.645 ± .007	.2276 ± .0026	20.4
481 D	1939	1,432	3.2670 ± .0079	.4424 ± .0055	.1354 ± .0025	
482 D	1939	290	1.3766 ± .0111	.2787 ± .0078	.2024 ± .0084	7.5
481 D	1940	5,436	2.7801 ± .0033	.3579 ± .0023	.1287 ± .0008	
482 D	1940	772	1.6640 ± .0075	.3072 ± .0051	.1846 ± .0032	16.9

Fig. 3. The upper row shows normal ripening fruits from the main part of the tree; the two lower rows show fruits from a late-ripening limb mutation of the same tree, photographed the same day (July 13). The center row presents an apical view of the late-maturing fruits. They show another peculiarity of this particular limb mutation, viz. an extremely large stylar scar.

TABLE 4—*Type and variability data for a cordate-shaped mutant of the Montmorency cherry and its parent form. Figures are for form indices* $\frac{\text{axial diameter}}{\text{transverse diameter}}$

Selection number	Year	Number fruits	Mean form indices	Standard deviation of form indices	Coefficients of variability of form indices	"T" test for significance
351(Nor.)D	1939	842	.8518 ± .0008	.0335 ± .0005	.0393 ± .0006	
350(LM)D	1939	1,652	.9756 ± .0007	.0439 ± .0005	.0439 ± .0005	5.7
351(Nor.)D	1940	938	.9723 ± .0010	.0434 ± .0007	.0446 ± .0007	
350(LM)D	1940	6,062	1.0984 ± .0005	.0590 ± .0003	.0537 ± .0003	12.0

Fig. 4. A branch of one of the late-maturing bud mutants of the Montmorency cherry, with leaves removed, showing extreme variability in maturing season. Photographed July 11. Some of the fruits are fully mature; others are half mature, still others are immature and would not ripen in less than 4 or 5 weeks.

large random samples of the fruits in 1939 and again in 1940. These form index data are summarized in Table 4.

EVENNESS OF RIPENING OF CHERRIES

One of the most frequently occurring bud mutations in the sour cherry is in season of ripening (Figs. 3 and 4). Scores of such variants have been noted and described in connection with the Station's study of bud variation, and a considerable number have been propagated. Most have been late-maturing strains; a few have been early-maturing. It has been observed that most strains, particularly the late-maturing ones, have been relatively uneven in ripening. Of course a certain degree of unevenness is normal for the cherry, this unevenness being influenced by many factors; relative size of crop as compared with the amount of foliage is especially important in this connection. Yet when conditions were comparable many of the mutations obviously were less uniform in their ripening than were their parent forms. To measure these differences quantitatively fractional pickings were made of both mutants and parent forms, the effort being to harvest at any one time only those fruits that had reached essentially the same degree of maturity. These harvest records (numbers of fruits harvested at successive dates) were then arranged in the form of frequency distri-

TABLE 5—*Type and variability data for 5 ripening season mutants of cherries, together with corresponding data for their parent or other "normal" forms*

Variety	Selection Number	Year	No. fruits	Mean ripening date	Standard deviation in ripening, days	"t" test for significance of differences in standard deviation*
Montmorency ..	607 (Normal)	1935	9,819	Aug. 3	3.6788 ± .0403	18.9
Montmorency ..	606 (Late)....	1935	5,946	Aug. 12	4.6092 ± .0285	
Montmorency ..	154 (Normal).	1935	25,581	July 12	4.64 ± .013	
Montmorency ..	162 (Late)....	1935	1,444	Aug. 14	2.57 ± .032	60.9
Montmorency ..	166 (Late)....	1935	17,815	Aug. 3	6.97 ± .025	83.2
Montmorency ..	391 (Late)....	1935	3,896	Aug. 6	7.95 ± .061	53.4
Montmorency ..	154 (Normal).	1940	12,000	July 10	0.00 ± .000	
Montmorency ..	162 (Late)....	1940	12,760	Aug. 3	7.014 ± .0296	237.0
Montmorency ..	166 (Late)....	1940	51,513	Aug. 5	6.473 ± .0131	494.1
Montmorency ..	391 (Late)....	1940	40,000	Aug. 4	5.621 ± .0190	296.4
Ey Richmond ..	148 (Normal).	1936	490	July 2	3.08 ± .066	
Ey Richmond ..	146 (Late)....	1936	219	July 13	3.48 ± .112	3.1
Ey Richmond ..	148 (Normal).	1937	2,201	July 9	2.73 ± .028	
Ey Richmond ..	146 (Late)....	1937	3,974	Aug. 4	5.88 ± .045	59.6
Ey Richmond ..	148 (Normal).	1940	7,677	July 18	3.318 ± .0098	
Ey Richmond ..	146 (Late)....	1940	23,392	July 31	8.009 ± .0025	464.4

*The "T" test for significance is calculated according to the formula:
Standard deviation of variable No. 1—Standard deviation of Variable No. 2

$\sqrt{}$ (Probable error of Standard deviation No. 1)^2 ± (Probable error of Standard deviation No. 2)^2
If the "T" test is 3 or above the difference between the two Standard deviations is significant at the 5% level.

bution tables, from which the mean maturity dates could be calculated together with the standard deviations therefrom in number of days. Table 5 presents in summary form the ripening season data for five such variants together with corresponding records for three parent or "normal" forms.

WEIGHT OF FRUIT IN APPLES

A number of size mutations in apples have been under observation for varying periods of time. Data on type and variability of three of them are presented in Table 6. One is a small-fruited limb sport of

TABLE 6—*Type and variability data for 3 size mutants of apple varieties and their parent forms*

Variety	Selection No.	Year	No. fruits	Mean weight grams	Standard deviations grams	Coefficient of variability	"T" test for significance
Jonathan	765 (Normal)	1934	194	96.21 ± .63	13.03 ± .45	.1354 ± .0047	28.4
Jonathan	766	1934	1,070	64.70 ± .43	20.83 ± .30	.3223 ± .0047	
Wealthy	110 (Normal)	1935	464	120.95 ± 1.113	35.55 ± .787	.2939 ± .0065	1.4
Wealthy	111	1935	1,841	150.03 ± .718	45.66 ± .508	.3043 ± .0034	
Hyslop	525 (Normal)	1934	539	29.511 ± .143	5.153 ± .101	.1746 ± .0034	7.4
Hyslop	524	1934	602	20.826 ± .123	4.469 ± .087	.2146 ± .0042	

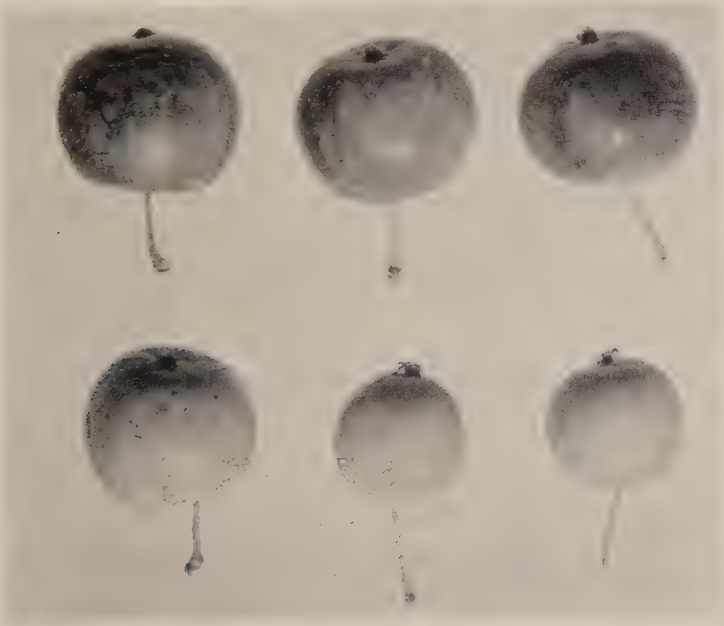

Fig. 5. The upper row shows three normal fruits of the Hyslop crab apple. The lower row shows three fruits of its small-sized, russet-surfaced limb mutation.

the Jonathan, the records being those of fruits harvested from the parent tree. One is a whole-tree large-fruited sport of the Wealthy variety; as a check against its fruits those of near-by normal tree carrying a comparable crop are presented. The third set of records are for daughter trees of a small-fruited limb variant of the Hyslop crabapple and the normal parent form (Fig. 5).

DISCUSSION

It will be noted that in the *majority* of instances for which data on type and variability are presented (Tables 1-6) the bud mutations are significantly more variable than are their parent or "normal" forms. On the other hand, in a *few* instances the mutations showed less variability than their parent forms (e.g. length of stem strains 623 and 361). A possible explanation of the greater variability that characterizes most of them is suggested by the data presented in Tables 7 and 8 presenting the 1940 frequency distribution tables for fruit stem length of 11 daughter trees of bud mutation No. 394, together with those of 7 daughter trees of the parent form (No. 394B). It will be noted that the daughter trees of the parent form show coefficients of variability in fruit stem length ranging from .1303 to .1570. The corresponding range for the daughters of the bud mutation is .1268 to .1900. On the whole the figures are somewhat higher. More important, however, is the fact that while the means for all the daughters of the parent form cluster closely around their center (1.404 $\pm$ .0025 inches), the means for the daughters of the limb mutation deviate much more widely from their center (1.830 $\pm$ .0023 inches). One of the daughters of the mutant (Tree 11-0) shows almost complete reversion to the parent normal form; three others (Trees 11-N, 14-N and 12-0) show partial reversion. One of these latter (Tree 11-N) and two additional ones (Trees 12-N and 16-0) show a tendency to have a bi-modal distribution in stem length. Only three of the 11 daughter trees (15-N and 13-0 and 15-0) present frequency distributions closely approaching that of the limb mutation as it appeared in the parent tree. From this reversion or segregation on the part of the daughter trees one is lead to the inference that the parent limb mutation is in reality a chimera in respect to fruit stem length and thus comparable to certain other bud mutations described earlier by the author and some of his associates (1). The fact that this relatively great variability of bud mutations, as compared with their parent forms seems to be the rule, lends still further support to an earlier interpretation placed on this apparently

TABLE 7—*Frequency distribution tables of fruit stem lengths of 7 daughter trees of Montmorency Selections No. 394B, the "normal" type, 1940 data. Compare with Table 8*

Stem lengths in inches	Row 19 Tree N	Row 20 Tree N	Row 21 Tree N	Row 19 Tree O	Row 20 Tree O	Row 21 Tree O	Row 22 Tree O	All 7 Trees
.6	.....	.....	.....	.....	.....	.....	.....	.....
.7	.....	2	.....	.....	.....	.....	.....	2
.8	.....	6	1	1	.....	.....	.....	7
.9	3	15	2	1	1	4	.....	26
1.0	10	57	22	1	2	22	9	123
1.1	33	91	28	1	3	21	13	186
1.2	67	203	97	9	10	80	41	509
1.3	121	187	71	6	19	45	24	485
1.4	122	307	156	27	42	81	68	800
1.6	136	148	73	11	31	17	32	447
1.6	119	194	111	40	106	26	92	682
1.7	99	109	28	19	37	6	23	326
1.8	41	52	41	18	69	2	35	259
1.9	11	9	3	5	13	.....	9	54
2.0	.....	5	6	4	18	.....	4	36
2.1	1	.....	2	.....	3	.....	.....	7
2.2	.....	.....	1	.....	2	.....	.....	3
2.3	.....	1	.....	.....	.....	.....	.....	1
2.4	.....	.....	.....	.....	.....	.....	.....	.....
2.5	.....	.....	.....	.....	.....	.....	.....	.....
2.6	.....	.....	.....	.....	.....	.....	.....	.....
2.7	.....	.....	.....	.....	.....	.....	.....	.....
2.8	.....	.....	.....	.....	.....	.....	.....	.....
Total No...	763	1,386	642	152	356	304	350	3,953
Mean length....	1.464 ± .0050	1.395 ± .0040	1.425 ± .0058	1.612 ± .0119	1.619 ± .0076	1.308 ± .0070	1.489 ± .0080	1.404 ± .0025
Standard deviation .	.205 ± .0035	.219 ± .0028	.217 ± .0041	.217 ± .0084	.211 ± .0053	.177 ± .0049	.221 ± .0056	.228 ± .0017
Coeffic't of variability	.1400 ± .0024	.1570 ± .0020	.1523 ± .0029	.1346 ± .0052	.1303 ± .0032	1.353 ± .0037	.1484 ± .0038	.1624 ± .0013

basic characteristic of bud sports—viz. that since they are chimeral in nature, intra-varietal or intra-strain selection to fix them is probably just as important as it is with seed-propagated forms.

It was found, however, that *some* of the bud mutations encountered in this study are no more, and others are significantly less, variable than are their parents. Presumably those that are strictly comparable with their parents in variability are not chimeral in nature or at least no more so than are their parents. At the other extreme, it may be assumed that certain bud-propagated varieties are themselves chimeral and basically variable in nature, and that they in turn give rise to bud mutations (segregates) that are non-chimeral and less variable in character. The solid red sports of many of the red-striped and splashed apple varieties conceivably may be mutations of this type.

TABLE 8—*Frequency distribution tables of fruit stem lengths of 11 daughter trees of Montmorency Selection No. 394, the long-stemmed mutation. 1940 data. Compare with Table 7*

Stem lengths in inches	Row 11 Tree N	Row 12 Tree N	Row 13 Tree N	Row 14 Tree N	Row 15 Tree N	Row 11 Tree O	Row 12 Tree O	Row 13 Tree O	Row 14 Tree O	Row 15 Tree O	Row 16 Tree O	All 11 trees
.6	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	1
.7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
.8	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
.9	.....	1	.....	6	.....	1	3	.....	.....	.....	.....	11
1.0	6	12	.....	34	2	17	15	.....	3	.....	5	94
1.1	9	13	1	28	3	18	23	.....	12	.....	3	110
1.2	28	41	9	110	4	77	44	.....	22	3	21	359
1.3	33	160	6	91	3	41	61	.....	27	5	12	339
1.4	75	107	20	256	17	108	95	7	77	8	51	821
1.5	79	78	22	150	20	38	67	3	78	10	37	582
1.6	198	155	57	240	42	89	108	21	184	42	102	1,238
1.7	160	102	64	93	50	24	52	19	144	20	57	785
1.8	321	201	125	103	71	39	64	50	268	52	118	1,412
1.9	185	112	74	35	81	5	40	43	156	34	71	836
2.0	266	204	149	16	73	12	30	81	267	75	109	1,282
2.1	184	83	100	5	89	3	18	79	146	56	57	785
2.2	188	123	114	1	83	1	8	22	219	102	84	1,002
2.3	53	39	54	1	44	.....	5	47	68	25	31	347
2.4	63	72	69	1	35	.....	2	9	86	68	53	492
2.5	29	17	26	.....	27	.....	.....	12	28	12	10	160
2.6	.....	29	19	.....	13	.....	.....	2	25	19	16	133
2.7	.....	6	7	.....	8	.....	.....	2	.....	9	4	35
2.8	.....	10	9	.....	.....	.....	.....	.....	.....	7	3	29
Total....	1,878	1,465	925	1,170	665	474	635	441	1,810	547	844	10,854
Mean.....	1.870 ± .045	1.84 ± .006	2.0 ± .006	14.9 ± .004	2.49 ± .009	1.45 ± .0075	1.56 ± .007	2.05 ± .008	1.901 ± .0049	2.06 ± .009	1.88 ± .008	1.83 ± .0023
Standard deviation	.290 ± .0032	.035 ± .004	.30 ± .0047	.226 ± .003	.36 ± .006	.246 ± .0055	.286 ± .006	.26 ± .006	.306 ± .0034	.31 ± .006	.33 ± .005	.353 ± .0016
Coefficient of variability	.1551 ± .0017	.1900 ± .0024	.1500 ± .0022	.1524 ± .0022	.1446 ± .0026	.1697 ± .0030	.1833 ± .0034	.1268 ± .0029	.1611 ± .0018	.1505 ± .0031	.1755 ± .0029	.1929 ± .0009

SUMMARY

Type (as indicated by the mean) of a number of bud mutations of the cherry and apple, and of their parent "normal" forms, was determined by suitable measurements of lengths and weights and by recording maturity dates. Variability of these same forms was calculated and expressed in the form of standard deviations and coefficients of variability. The significance of the differences found was then determined by suitable statistical tests. The mutations that were studied readily fell into three groups or categories:

a) The *majority* of the bud mutations and their vegetative progeny were significantly more variable than their parent clones. Reversions and segregates are of rather frequent occurrence when these relatively variable bud mutations are propagated vegetatively.

b) A certain percentage, apparently less than a third, of the bud mutations in these fruits exhibit essentially the same degree of variability as their parent clones.

c) A third group, again apparently less than a third in the forms studied, exhibit significantly less variability than their parent clones. These relatively uniform strains are interpreted as being segregates from mixed or chimeral parent forms.

Selection to fix type in bud mutations, especially those of the first category, is necessary if a relatively uniform variety or strain is desired.

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LOSSES OF CALVES IN DAIRY HERDS

By EARL WEAVER, RUSSELL E. HORWOOD and E. S. SMILEY
SECTION OF DAIRYING

WHILE THE CHIEF items of income for dairy farmers are the milk and cream, the sales of cattle can also be significant for those Michigan dairymen having good purebred herds. It is estimated that only about 6 or 7 percent of Michigan's dairy income is derived from the sales of cattle. This figure includes both those animals sold for dairy purposes and those that are vealed and slaughtered for various reasons.

The amount of income from the sale of purebred animals is too low. Most purebred herds face difficulties in raising enough females for necessary replacement. Excessive calf losses impose serious handicaps. From the evidence that can be secured, mortality among dairy calves far exceeds that among beef calves.

It should be realized that severe epidemics among dairy calves are more frequent and more disastrous in large herds than in small herds. Savage and McKay (5) report that Slack and Harrison in studies with the Cornell University herd found that calf losses ran as high as 20 percent when the calves were raised in the conventional manner in a large herd. When the system was changed to one of segregating the calves into smaller but properly constructed units and to handling each calf in a separate pen the mortality dropped to 6.7 percent. In the latter case the calves were notably freer from pneumonia or similar diseases.

One of the earliest reports in the literature on the question of calf losses was by Ragsdale, Elting and Brody (4). In the Missouri University herd of four breeds they studied 943 pregnancies. Of these 10.1 percent were aborted, 8.0 percent died at birth. Of the calves that were carried full term and survived birth, 5.6 percent died later. In a later report from Missouri, Herman (3) indicated that 5 percent of the calves were born dead and 8.2 percent died before a year old.

Selby and Kuhlman (6) in an extensive survey in Oregon found

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that on all types of farms and with both grades and purebreds, mortality among female dairy calves was high. Over a 4-year period and covering 574 farms, 14.4 percent of the female calves that were born alive died before freshening. These authors particularly emphasize the high costs in the calf-rearing enterprise that are imposed on surviving heifers when too many other calves are lost.

Angels and Cannon (2), in a study of the Iowa State College herd for the period 1907-35, report that 600 females were born. Of these, 3.3 percent were born dead. Then 14.4 percent were lost by death prior to first freshening, a figure identical with that from Oregon.

The Iowa study further revealed the startling fact that another 7.8 percent of the heifers attained breeding age and then had to be sold for slaughter because they would not breed.

Wing (7) in his report of the Cornell University herd indicates that 7.6 percent of the calves were born dead and of the calves born alive, 9.5 percent died before they were 3 months old. Later in another study in the Cornell University herd, Savage and McKay (5) included 1352 pregnancies. Eight percent of the calves were born dead, and 5.7 percent more died within the first year.

The causes of calf deaths have received study by some workers. Herman (3) as indicated previously, found that 8.2 percent of the calves died before a year old. The causes were diagnosed as follows: Scours 32 percent of the deaths; pneumonia, 24 percent; digestive disturbances other than scours, 9.7 percent and the remaining deaths were due to other causes. Atkeson (1), with the University of Idaho herd, found that of all normal births, 8.0 percent of the calves died before 6 months old. Thirty percent of the deaths were due to pneumonia; 25 percent to scours; 10 percent to navel infection.

It is recognized that correct diagnosis of the exact cause of a calf's death is difficult; complications often develop. But it is apparent that a half to two-thirds of calf deaths that are encountered are due either to scours or pneumonia or both.

PROCEDURE

The study reported here involved data on the five breeds in the Michigan State College herd covering a period of 16 years from July 1, 1932 to June 30, 1948. The study included the calves until they had passed the tenth month of age. This age was arbitrarily accepted. Until this age both male and female calves are handled similarly; it was desired to include as many calves as possible. Beyond this age

records on bull calves are not maintained because the bulls have been sold. The data on the calves older than 10 months added no important facts.

Also use was made of the records of the Upper Peninsula Station herd at Chatham for the period July 1, 1932 to June 30, 1941, and of the Kellogg Farm Guernsey herd at Augusta for the same period.

EXTENT OF LOSSES

Table 1 gives by fiscal years the numbers of calves (both male and female) born in all the herds studied and the percentages of the calves lost at the different stages.

During the entire period a total of 1467 calves were born. It was noted that the numbers declined since 1941 because the records of the Chatham and Kellogg herds are not included. For these years since 1941 all the calves were born in the main College herd at East Lansing.

Of the total calves born, 5.5 percent were dead at birth. This figure includes abortions. Attention is called to the fact that at no time was any cow in any of the herds positive to the agglutination test for brucellosis. All the herds have been continuously accredited as brucellosis-free herds.

The high figures of 14.2 percent for calves born dead in 1947 and of 10.2 percent for 1946 are disturbing. In 1947 two sets of twins were born. Both twins in both sets were dead at birth. Also in 1947 some cultures from the calves that were dead at birth revealed the presence of vibrio fetus. It is believed this organism was involved.

TABLE 1—*Numbers of calves born and percentage losses*

Year ending June 30	Number born	Percentage			
		Born dead (including abortions)	That died at birth	That survived birth and died prior to end of 10th month	Total losses
1933	95	4.2	2.1	4.2	10.5
1934	97	6.2	1.0	9.3	16.5
1935	97	8.2	1.0	14.4	23.6
1936	111	1.8	0.0	10.8	12.6
1937	115	4.3	3.5	7.0	14.8
1938	94	5.3	0.0	6.4	11.7
1939	116	5.2	.9	6.9	13.0
1940	104	1.0	1.9	8.7	11.6
1941	111	5.4	1.8	6.3	13.5
1942	83	8.4	1.2	3.6	13.2
1943	71	4.2	2.8	7.0	14.0
1944	78	2.6	0.0	10.3	12.9
1945	62	6.5	0.0	6.5	13.0
1946	79	10.1	0.0	3.8	13.9
1947	77	14.2	0.0	5.2	19.4
1948	77	2.6	0.0	0.0	2.6
Total	1467	5.5	1.1	7.1	13.7

Apparently such infection as may have existed in 1946 and 1947 had subsided by 1948 because the record for that last year was favorable, when only 2.6 percent of the calves were born dead.

The number of calves that died at birth was quite low—only 1.1 percent. Also for seven of the years none of the calves died at birth.

Seven and one tenth percent of the calves died subsequent to birth and prior to the end of the tenth month. This constituted over half of the total losses. Attention is called to the high losses of 14.4 percent in 1935 and 10.8 percent in 1936. Pneumonia ravaged the herds both years and was serious in the midsummer as well as in winter seasons.

During the period about 1940 confidence arose that calf losses after birth were being effectively prevented. The sulfa drugs were being used successfully, expanded steel calf mats were installed in the individual pens; the individual pens were equipped with fiber board to provide segregation and prevent direct drafts; nipple pails were used exclusively for the younger calves. But in spite of this apparent progress a serious problem arose again in 1944 when 10.3 percent of the calves died even after getting a good start. But in general there has been marked improvement in saving the calves that once get started. In 1948 for the first time no calf was lost.

The total losses over the 16-year period have averaged 13.7 percent, ranging from a high of 23.6 percent in 1935 down to 2.6 percent in 1948. This average figure is in close agreement with those reported from the Oregon and Iowa studies but somewhat higher than the figures from Missouri and Cornell Universities.

AGES WHEN DEATHS OCCURRED

Angels and Cannon (2) and Ragsdale, Elting and Brody (4) showed that deaths among calves were most serious at the youngest ages. The former workers found that 5.9 percent of the female calves born died within the first month, 5.2 percent from 1 to 3 months old; 1.5 percent when 4 to 6 months and 0.7 percent when 7 to 12 months.

From Angel's and Cannon's work it was found that of the 86 deaths subsequent to birth and prior to first freshening 40.7 percent occurred the first month; 36.0 percent from 1 to 3 months old; 10.5 percent from 4 to 6 months, and 4.7 percent when 7 to 12 months.

Ragsdale, Elting and Brody recorded a total of 73 calf deaths. Of these 53.4 percent died at birth. Of 34 calves that survived birth but died before 6 months of age, 50.0 percent of them died the first week,

TABLE 2—*Losses of calves at various ages after birth and before end of tenth month*

(Based on a total of 1371 calves born alive)

Age when calf died	Number of deaths	Percentage	
		Of total calves that were born alive but died at the age indicated	Of the total deaths that occurred at the age indicated
First week	32	2.3	30.2
Second to fourth week	15	1.1	14.4
Second month	26	1.9	25.0
Third month	12	0.9	11.5
Fourth month	6	0.4	5.8
Fifth month	4	.3	3.8
Sixth month	6	.4	5.8
Seventh to tenth month	3	.2	3.8
Total	104	7.6	100.0

or 64.7 percent the first month or 76.5 percent by the end of the second month.

Table 2 gives the data from the Michigan study on the losses at various ages. The data are not shown for the separate years but for the entire 16-year period. The figures for the separate years do not reveal any facts that cannot be obtained from Table 1.

Table 2 confirms the work of others and the observations of dairymen that most serious losses occur at the earliest ages. Of all deaths, 30.2 percent occurred the first week and a total of 44.6 percent the first month.

This mortality figure is considerably lower than that of 64.7 percent from the Missouri work but comparable with the figure of 40.7 percent as reported from the Iowa study.

Twenty-five percent of the deaths occurred in the second month. For the older calves the mortality rate showed a quite consistent decline.

SUMMARY

1. A study of the records of the dairy herds operated by Michigan State College indicates that calf losses over a period of 16 years have been considerable. Of 1467 calves born, 13.7 percent failed to survive beyond the tenth month of age. This mortality figure is comparable to those from the other studies that are cited.

2. Five and one-half percent of the calves were born dead. Unfortunately the losses of calves that were born dead were almost as severe in the later years as earlier. No brucellosis has ever been

found in the cows; still the number of calves born dead has not declined as would be desired. It is mentioned, however, that this percentage of the calves that are born dead is considerably lower than that reported by other workers.

3. One and one-tenth percent of the calves died at birth. Taken in conjunction with the 5.5 percent that were born dead it is observed that 6.6 percent of the calves failed to survive birth. This is nearly half of the total losses. More success has been enjoyed in recent years in saving these calves after they once get started.

4. Calf deaths are especially numerous at younger ages.

5. The pail-feeding of calves, which is necessary in most herds, is a departure from the natural environment. This imposes hazards that many calves fail to survive. To meet the critical situation necessitates care in disease prevention, in housing and especially in the feeding of the calves.

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INHERITANCE OF MEAT TYPE AND WEIGHT OF DARK CORNISH, WHITE LEGHORN AND RECIPROCAL CROSSBRED CHICKENS

By EARL W. HENDERSON
SECTION OF POULTRY HUSBANDRY

IT IS COMMON KNOWLEDGE among poultrymen that good meat type, as measured by a relatively plump breast, is inherited. It is equally well known that adult body weight and growth rate as measured by weight at a specified common age are inherited. The degree and extent of inheritance and the circumstances which affect the characteristics are not so well known.

Evidence of what happens to meat type and weight when two divergent populations are crossed under specified conditions is presented in Table 1. Meat type is measured by a score ranging from "1" (best) to "5" (poorest). Weights are recorded at 16 weeks of age.

That some good meat-type criteria are inherited is not news to poultry breeders, but there is still considerable variance in ideas as to what constitutes good meat type in market channels as well as among producers. Market graders distinguish between "light" and

TABLE 1—*Meat type scores and weights of 16 week-old chickens by ancestry**

Sex	White Leghorns		Dark Cornish X White Leghorn		Dark Cornish		White Leghorn X Dark Cornish		Total No.
	No.	Ave. Score	No.	Ave. Score	No.	Ave. Score	No.	Ave. Score	
Males	67	3.10**	63	2.84	64	2.87**	54	2.88	248
Females	70	3.06**	68	2.89	69	2.78**	67	2.88	274
	No.	Ave. Wt. Lb.	No.	Ave. Wt. Lb.	No.	Ave. Wt. Lb.	No.	Ave. Wt. Lb.	Total No.
Males	64	2.87	84	2.91	60	2.65**	58	3.01**	266
Females	76	2.30	75	2.17	57	2.18	60	2.46**	268
									1056

*Progeny from five pairs of single-male mated pens. Leghorn Cornish males were alternated between pairs of pens to obtain purebred and crossbred sibs from the same dams in the same hatch, in an attempt to equalize environment.
**High degree of statistical significance by analysis of variance. For evidence see Appendix.

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"heavy" fowl and pay a premium for "heavy" chickens as a rule, probably on the assumption that there is a greater proportion of edible meat on heavy chickens than on light. Extremely choice, richly-fleshed, broad-breasted birds have been well known among poultry fanciers for several decades and centuries perhaps, but the possibilities of developing this characteristic more generally have not been realized in this modern age.

At least one breed of chickens which has the broad-breasted or meat-type characteristic well established is the Cornish. Although the Cornish is supposed by many to have the same primitive ancestors as other breeds the utility of crossing Cornish with so-called egg-type breeds for broiler purposes is not generally accepted. There have been a number of reports of crosses with the Cornish both prior and subsequent to those of Henderson and Davidson (1941) and Davidson, McCrary and Card (1945). A recital of the ancestry of the meat type idea is not considered essential to this report. Producers seem to require more evidence however of the possibilities of improving meat type both within breed categories as well as by cross breeding.

OBJECTIVES OF EXPERIMENT

The objectives of the general project from which this partial report is made were to measure the performance of purebred and reciprocal crossbred progenies. The characteristics of performance reported herewith are meat type, as defined by Henderson (1945) and (1946) and weight at 16 weeks of age.

STOCKS AND METHODS

The samples of breeds compared in this experiment consisted of White Leghorns, Dark Cornish, and progeny from reciprocal crosses of the two. The White Leghorns were from the Michigan State College Poultry Department flock which had been bred prior to 1941 almost entirely as a "closed" flock at least.[1] From this flock five lines have been developed since 1941, by inbreeding of varying intensity. The Cornish flock has been bred since 1942 rather roughly along five production lines, from 11 unpedigreed females and five presumably unrelated males. Matings were adjusted with intent to get purebred and crossbred chicks out of the same dams in the same hatch for pairing. This was accomplished by alternating the same Leghorn and

[1]Flock supervised by Associate Professor J. A. Davidson, 1935 to 1941.

Cornish males a week at a time between a Leghorn and a Cornish pen. The result of the mating procedure was that in most cases sib progeny were obtained from most of the dams in each hatch by both sires but, of course, seldom in equal numbers.

All chicks of this report were hatched in the spring of 1947, most of the hatches being two weeks apart in April. Differential growth rates between hatches have been noted in Missouri by Kempster and Henderson (1923) and Kempster and Parker (1936). It was necessary therefore to determine whether there was an important difference between hatches in this experiment. By analysis of variance a "t" value of 1.3 was determined which was far from significant, and indicated that the weight of the different hatches could be pooled, without bias. Attempted restriction of the sample to an ideal of a single pair of half sibs from each dam in each hatch reduced the numbers below a significant level in some cases. The data are grouped by breeds in Table 1. The birds were scored as caught off the range, entirely at random and without previous knowledge of their ancestry.

ANALYSIS OF RESULTS

MEAT TYPE—MALES

In the case of the males a test for general significance between breeds by analysis of variance yielded a "t" value of 14.3 which is highly significant from Baten's (1938) tables. From the averages alone it seems obvious that the principal difference is that between the White Leghorns and the Dark Cornish X White Leghorn cross. The crossbred means did not differ significantly among themselves nor from the Cornish but all differed from the mean of the Leghorns. Dominance of the Cornish meat type may be implied by this result but not heterosis.

All the meat-type mean scores except those of the Leghorns were not so good as those estimated for 24-week-old birds by Henderson and Davidson (1941). It is surmised that this represents a difference among age groups instead of degeneration of the strain because adult Cornish scores in the general flock appear to be as good as those reported from a different Cornish strain in 1941. Apparent improvement in Leghorn meat-type score above those of 1941 might be inferred, but these data are not offered as proof because of the age difference between the observations.

MEAT TYPE—FEMALES

From tests for general significance of means among females with respect to meat type a "t" value of 9.8 was obtained which is highly significant. The Cornish were significantly better than the crossbreds, and the Leghorns were significantly poorer than the crossbreds.

WEIGHT OF MALES

Differences among the mean weights of males were highly significant in general but most of the difference was obviously between the low weights of the Dark Cornish and the others.[2] The crossbreds did not differ significantly among themselves nor from the White Leghorns. The "t" value between the Leghorn and the Cornish X Leghorn cross was 1.96—not significant. The difference between the Cornish and Leghorn X Cornish F_1 is highly significant obviously.

WEIGHT OF FEMALES

The differences among the means of the weights of females were highly significant in general. There was no significance between the Cornish X Leghorn crossbreds and the Cornish but the difference between the Leghorns and the Leghorn X Cornish cross was highly significant ($t = 8.0+$). Apparently the Leghorns sires had more influence on the growth of their progeny than that of the average of both breeds of dams. This might seem logical since Leghorn males are commonly selected from the best possible portion of a population. On the other hand it could be inferred that the Cornish dams were superior to the Leghorn dams when mated to the same Leghorn sires, and to the Cornish sires, when mated to Leghorn dams. The Cornish males have been inbred primarily from the best laying Cornish families, with some compromises perhaps with respect to other criteria and meat type. Heterosis might be postulated in explanation of the superior growth rate from the Cornish dams and/or Leghorn sires, but the sire population is very small compared with that of the dams. The Leghorn X Cornish male progeny was superior from four out of five pens, and the same female progeny was superior from all five pens.

Additional segregation of the data on the basis of relative inbreeding is suggested and possible for future study because all chicks were

[2]Analysis of weight data of White Leghorn, White Leghorn X Cornish and Cornish White Leghorn cross did not yield significance.

individually pedigreed, and their ancestry can be traced for more than four generations in the case of the Cornish and many more than four generations in the case of the Leghorns.

SUMMARY AND ABSTRACT

Averages of meat type scores by a scale ranging from (1) best to (5) poorest were statistically significant in general from the following 1056 paired 16-week-old purebred and reciprocal crossbred progenies. White Leghorn males 3.10, females 3.06—Dark Cornish males 2.87, females 2.78—Dark Cornish X White Leghorn males 2.84, females 2.89—White Leghorn X Dark Cornish males 2.88, females 2.88. Weights in pounds at the time of scoring were White Leghorn males 2.87, females 2.30 — Dark Cornish males 2.65, females 2.18 — Dark Cornish X White Leghorn males 2.91, females 2.17 — White Leghorn X Dark Cornish males 3.01, females 2.46.

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APPENDIX

STATISTICAL EVIDENCE

For the sake of brevity the four breeds in the foregoing report are numbered herewith as follows: Single Comb White Leghorn, No. 1; Dark Cornish White Leghorn cross, No. 2; Dark Cornish, No. 3; and White Leghorn Dark Cornish cross, No. 4.

The principal analyses of variance summaries are as follows:

I. A. (1) For general significance

SCORE—MALES

	D/F	Sum of Squares	Mean Squares	t
Total	247	16.03		
Between Breeds	3	2.37	.79	14.3
Within	244	13.66	.055	

(2) 2 VERSUS 3

Total	126	8.48		
Between Breeds	1	0.00	0.00	
Within	125	8.48		

B. (1) SCORE—FEMALES

Total	273	30.52		
Between Breeds	3	2.99	.999	9.8
Within	270	27.53	.101	

(2) 3 VERSUS 4

Total	135	15.50		
Between Breeds	1	.58	.58	5.2
Within	134	14.92	.11	

II. A. General significance WEIGHT OF MALES

Total	265	82.75		
Between Breeds	3	4.24	1.41	4.7
Within	262	78.51	.299	

(1) 1 VERSUS 4

Total	121	37.72		
Between Breeds	1	.61	.61	1.96
Within	120	37.11	.31	

(2) 1, 2 AND 4

Total	205	57.54		
Between Breeds	2	.64	.32	1.10
Within	203	58.90	.29	

(3) 2 VERSUS 4

	D/F	Sum of Squares	Mean Squares	t
Total	141	41.19		
Between Breeds	1	.34	.34	1.17
Within	140	40.85	.29	

B. (1) WEIGHT OF FEMALES

Total	267	42.90		
Between Breeds	3	3.36	1.12	7.55
Within	264	39.54	.149	

(2) 1 VERSUS 4

Total	135	17.79		
Between Breeds	1	1.07	1.07	8. +
Within	134	16.72	.125	

(3) 1 VERSUS 2

Total	150	24.63		
Between Breeds	1	.45	.450	2.3
Within	149	24.18	.194	

In one of the five Leghorn pens four out of five dams were from unknown and presumed unrelated ancestry mated to a male of the Michigan State College strain. The average weight of their progeny was significantly more than that of all other Leghorn dams. Tests with this pen being omitted merely reduced the "t" value from 4.7 to 4.47. The average meat type score of this same progeny was identical with the mean.

WATER AND ALKALI REQUIRED TO WASH MILK BOTTLES*

By P. S. LUCAS
SECTION OF DAIRYING

NO OTHER OPERATION in the milk plant, unless it is that of operating the refrigerating system, makes use of water to the extent that is required for the washing of milk bottles. In the management of a milk plant or in consideration of the erection of such a plant it is well, therefore, to know the approximate demands for water in order that provision may be made to supply the peak quantity required.

In the following study, a four-row, brush-type Meyer-Dumore Jr. bottle washer was used and quart, pint and half-pint standard milk bottles were washed in numbers specified in Tables 1, 2, and 3. The water used was metered, readings being made at the beginning and at the end of each day's run. The plant supplying the data possesses two equal size water softeners, each of which supplied the soft water used by the washer on alternate days. The figures secured for amounts of water used per bottle may be used advantageously also as a guide for purchase of softeners of adequate capacity.

The initial charge of the bottle washer was 526 gallons of water and 150 pounds of flake caustic. Records were kept of the alkali as added at intervals and the strength of the washing solution at the start and end of the day's operation. In Table 3, columns 1, 2, and 3 under "strength of solution" show, respectively, total alkalinity, active caustic strength, and soda ash.

The figures supplied on the amount of caustic required to wash a quart bottle would not be applicable in case hard water had been

*In the first paper of this series, "Some Chemical and Physical Properties of Dairy Cleaners", page 254, Michigan State College Quarterly Bulletin, Vol. 30, Number 4, May, 1948, titration values, using methyl orange and phenolphthalein as indicators, were given to indicate the buffering value of each washing powder used. The test may also be used for determination of carbonates in carbonate cleaners; it is not valid for such carbinate values in cleaners other than carbonates (see pp. 454-5 in reference cited). The value was referred to as carbonates rather than as buffering value. This statement applies to all the cleaners mentioned: 7, 9, 10, 12, and 16. They may or may not contain carbonates so far as this publication is concerned, since no analyses at any time for composition were made. The point is that those numbers mentioned were well buffered. Method for analysis in such cases is given by Little in the Journal of Dairy Science, Vol. XX, No. 2, pp. 93-101, 1947.

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used, for the reason that soft water was used in these trials. The amount of detergent required to soften water of varying degrees of hardness may easily be ascertained, however, and the amount added to those values secured in this study. Also, values may vary in proportion to the value of the detergent as a water softener.

The trial periods used in ascertaining the amounts of water and alkali used covered intervals of 68, 33, 26, and 14 days. In the course of normal operations the sizes of bottles washed included quarts, pints, and half-pints and the numbers of these have been listed. In order that these types might be converted to their equivalent in quarts, Baten and Lucas[1] measured the total, inside and outside, surface exposed to the action of the detergent. On the basis of surface the three types of bottles washed have been converted into a surface equivalent for quarts. Thus the combined surface of 1321 quart, 254 pint, and 1015 half-pint milk bottles is equivalent to the combined surface of 1895 quart milk bottles. These equivalents were obtained by multiplying the number of pint bottles by 0.62 and the half-pints by 0.41. These factors were secured by actual measurement of the surfaces of the three sizes of standard milk bottles, these being 200.4, 123.88, and 82.33 square inches, respectively, for quart, pint, and half-pint bottles.

Records have been kept at intervals during the past three years of numbers of bottles washed, and the amounts of soft water and of alkali used. The strength of a cleaner is reduced in proportion to its value as a water softener and in proportion to the degree of hardness of the water.

For the sake of space figures for the trial periods of the first three just mentioned were totaled. During these periods a total of equivalent quarts amounting to 265,086.5 were washed. A summation of the several pages of data is given in Table 1.

The calculation shows that with the type of bottle washer used and using soft water, 0.86 gallon of water was used to wash one quart

TABLE 1—*Water and alkali used to wash milk bottles*

Water used: gallons	Alkali used: pounds	Bottles washed: quart equivalents
228,847	447	265,086.5

[1]W. D. Baten and P. S. Lucas: A Method For Surface Area Measurement Of Milk Bottles, J. of Dairy Sc., August, 1942, Vol. XXV, No. 8, Pages 663-665.

bottle or its equivalent. This is much greater than is commonly considered, and accounts in part for the usually underestimated amount of water required for a dairy plant. The amount will vary with the type of water used, and it may serve as an index of water-softening capacities required in case a plant may consider installation of softeners.

It should be noted that the last period of record keeping covered 14 days only.

The bottle washer was charged with the standard amount of alkali and run for 14 days without recharging. A pH of the washing solution was made at the end of each day's run. As the pH approached acidity the figures show the gradual lessening alkalinity of the washing solution and, therefore, its gradual weakening through amounts used up in emulsifying fat and neutralization by dairy waste.

The frequency of changing the water in the bottle washing machine affects considerably the amount of cleaner required per bottle. In the same 68-, 33-, 26-, and 14-day periods the amounts of special alkali required per bottle were 0.0336, 0.048, 0.072, and 0.0848 ounce respectively. This means an increasing ratio from 100, to 143, 214, and 282 percent. During the first three trials the strength of the alkali was maintained by frequent small additions; during the last it was permitted to decrease to a point where it became too low for efficient use. Using the first three periods for calculation of alkali required per bottle gives a value of 0.03 ounce per quart bottle. Daily skimming of the oily film from the washer solution and provision of a false bottom in the solution tank to prevent agitation of settled-out heavy sediment will permit longer use of the cleaning solution.

TABLE 2—*Showing water and alkali used to wash milk bottles without alkali additions*

Day	Water used: Gal.	Alkali used: Lb.	Bottles washed			Equiv. Qt.
			Qt.	Pt.	half-Pt.	
1	1,770	150	1,500	274	1,025	2,090.2
2	1,550	.....	1,246	328	1,140	1,916.8
3	1,780	.....	1,476	305	1,215	2,163.3
4	1,150	.....	1,328	325	825	1,867.8
5	1,210	.....	1,008	91	637	1,325.6
6	1,760	.....	1,387	420	1,364	2,206.6
7	1,740	.....	1,572	322	1,209	2,267.3
8	1,730	.....	1,315	238	1,134	1,927.5
9	1,690	.....	1,224	333	1,388	1,999.6
10	1,040	.....	1,628	444	1,270	2,424.0
11	1,350	.....	1,296	157	1,065	1,830.0
12	1,670	.....	1,212	78	836	1,603.2
13	1,970	.....	1,516	560	1,183	2,348.2
14	2,200	.....	1,440	313	1,336	2,181.9
	22,610	.....	.....	.....	.....	28,152.0

TABLE 3—*Decline in alkaline strength during use when alkali was not added as needed*

Day	Water used in Gal.	Strength of solution									Quart bottle equivalent
		At start of washing			At end of washing			pH			
		Total alkalinity	Active caustic	Soda ash	Total alkalinity	Active caustic	Soda ash	Start	End	Corrected end pH reading	
1	1,770	4.05	4.00	.07	4.05	4.00	.07	11.20	10.95	12.15	2,090.2
2	1,550	4.05	4.00	.07	3.95	3.85	.12	10.95	10.95	12.15	1,916.8
3	1,780	3.95	3.85	.12	3.90	3.80	.20	10.95	10.91	12.11	2,163.3
4	1,150	3.90	3.80	.20	3.80	3.68	.20	10.90	10.91	12.11	1,867.8
5	1,210	3.80	3.68	.20	3.75	3.63	.30	10.90	10.85	11.55	1,325.6
6	1,760	3.70	3.63	.30	3.60	3.48	.32	10.85	10.90	12.15	2,206.6
7	1,740	3.60	3.48	.32	3.57	3.36	.38	10.90	10.92	12.17	2,267.3
8	1,730	3.51	3.36	.38	3.50	3.35	.40	10.90	10.85	11.75	1,927.5
9	1,690	3.50	3.36	.40	3.50	3.33	.41	10.85	10.85	11.75	1,999.6
10	1,040	3.50	3.30	.41	3.40	3.20	.50	10.86	10.88	11.78	2,424.0
11	1,350	3.40	3.20	.55	3.35	3.15	.59	10.85	10.80	11.60	1,830.0
12	1,670	3.35	3.15	.55	3.30	3.05	.53	10.80	10.75	11.40	1,603.2
13	1,970	3.27	3.04	.52	3.20	2.95	.55	10.75	10.80	11.60	2,348.2
14	2,200	3.22	2.95	.55	3.10	2.90	.56	10.75	10.80	11.60	2,181.9

RECOVERY OF A SOUTHERN MICHIGAN TROUT STREAM

By W. F. MOROFSKY, P. I. TACK, and W. A. LEMMIEN[1]

Sections of Entomology, Zoology and Forestry

The stream under consideration is that section of Augusta Creek lying on the Kellogg Forestry Tract situated in Ross Township, Kalamazoo County, T1S—R9W, Section 21, 22, and 27. This section of stream is approximately 1.8 miles in length and is near the lower end of the stream. The total length of the stream is approximately 25 miles and has many tributaries.

This stream has been under study since 1934. It had been regarded as a brook trout stream and had been stocked consistently with brook trout until 1946 when the management policy was changed and brown trout were planted instead. Brown trout had been planted on three previous occasions, in 1924, 1927, and 1934, according to Conservation Department records. Previous to 1946 the creel census was not on a well organized basis, and the results of these plantings are not apparent. In general, however, the stream yielded less than satisfactory trout fishing during the years brook trout were consistently planted.

The fish planted in this section of stream are free to move beyond the limit of this tract at will since it has proved impracticable to place barriers at the property limits.

INSECT SURVEY

Prior to 1934, Augusta Creek had a gravel bottom covered with sand and muck varying from 2 inches to 2 feet caused primarily by spring floods, sluggishness and erosion. A large portion of the stream runs through open meadows with little protection against meandering.

Bottom types representative of the entire one and eight-tenths miles of stream were marked by stakes and sampled by means of a

[1]The authors wish to express their appreciation to the Fish Division of the Michigan Department of Conservation for excellent cooperation in stocking the stream with trout and for suggestions and criticisms.

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1-square-foot bottom sampler on these established areas. These insect samples were taken before and after alteration of the stream. About two inches of bottom was taken at each station and the animal life was placed in a preservative with date and locality and later identified. The 1934 survey showed that 85.3 percent of the animals collected were insects and that 14.7 percent were other animals such as mollusca and crustaceans. Then during the summer of 1934 after the insect survey had been made, a stream alteration project was conducted with the idea of bettering conditions for both insects and fish. Thirty-one covers, barriers, deflectors and similar devices were installed.

During 1935 another insect count was made at the same stations and by the same methods used in 1934. This showed that 53.6 percent of the animals collected were insects and 46.4 percent others, but that the total numbers of insects had increased 17 percent. This was perhaps due to the removal of the deposits of muck and silt overlying the gravel by scouring resulting from stream alterations. This procedure continued until 1939 when sampling showed 90.2 percent insects present in the stream and only 9.8 percent of other animals present. Since that time over one hundred barriers, deflectors and other devices have been installed. The last insect sampling taken in 1948 showed that aquatic insect populations were similar to those in 1939.

A survey of terrestrial insects was also made on this area which showed 18 orders of insects present, many of which serve as a fish food.

STOCKING THE STREAM

The size, number and kind of fish planted in this section of stream since 1940 are listed in Table 1. It will be noted that the stream was heavily stocked, but the area is easily accessible to sportsmen from the cities of Battle Creek and Kalamazoo as well as numerous nearby

TABLE 1—*Planting schedule for Augusta Creek on the Kellogg Forestry tract*

Year	Species	Average length	Number
1941	Brook trout	Yearlings	1,000
		3 months	6,000
		7 months	1,000
1942	Brook trout	Yearlings	500
1943	Brook trout	Yearlings	1,200
1944	Brook trout	7″ – 10½″	300
1945	Brown trout	8″	700
1946	Brown trout	7″ – 8″	1,600
1947	Brown trout	8½″	800
1948	Brown trout	7½″ – 9½″	2,400

villages. Hard surfaced roads run to within a few feet of the creek in many places.

CREEL CENSUS

Angling on the Kellogg Forestry Tract is by permit, with the stipulation that the fish be submitted for inspection and collection of the stomachs for food studies. Fish planted subsequent to 1946 were marked by clipping the dorsal fin in 1947 and the adipose fin in 1948. This permits the identification of the year the fish were stocked. The creel census results can best be shown in tabular form (Table 2).

In addition to the records in table 2, 180 brook trout were taken from this area in 1942, and in 1943, 315 were recorded. The total fishing effort was not recorded nor was the number of anglers. It is noteworthy that 144 of the 180 taken in 1942 were reported on the opening day of the season, while in 1943 225 were taken on the first day.

DISCUSSION OF RESULTS

The markings, as described above, lead to interesting information on survival from one year to another. For instance, among the 473 brown trout caught in 1947 there were 156 that did not have their fins clipped, that is, they had survived from previous plantings or were native to the stream. The remaining 317 brown trout caught that year represent very nearly 40 percent of those planted which is higher than other figures for this state as reported by Shetter and Hazzard (1941).

TABLE 2

Year	Species	Number	Number of anglers	Hours of angling	Fish per hour
1946	Brown trout	344			
	Rainbow trout	25			
	Brook trout	4			
		373	133	725	0.51
1947	Brown trout	473*			
	Rainbow trout	9			
	Brook trout	2			
		484	260	1,350	.36
1948	Brown trout	629**			
	Rainbow trout	13			
	Brook trout	9			
		651	397	1,975	.33

*156 of the brown trout taken this year were planted in 1945, 1946 or were native.
**33 brown trout of this group were planted in 1947 and 47 were either native fish or were planted in 1946 or earlier.

A similar analysis of the creel census for 1948 yields equally interesting results. Of the 629 brown trout reported in 1948, 33 had the adipose fin missing, indicating they were stocked in 1947, and 47 without clipped fins were probably partly native fish and partly survivals of the 1946 or earlier plantings as indicated by their relatively large size (14-21 inches). Thus we have accounted for 44 percent of the 800 brown trout planted in 1947, which is an unusually high return. The recapture of brown trout planted in 1948, however, was only 25 percent. This figure is more nearly in line with other results for the state, although one should consider that 500 of these were planted in August, near the close of the season. If one adjusts the figures to the extent of eliminating the last 500 fish stocked from consideration, the return is 32 percent, still in line with the values reported by Shetter and Hazzard (1941).

RETURNS TO THE ANGLER

There was a marked gain in the number of anglers and in hours of angling on the tract. In comparing this increase in angling pressure with the increase in number of fish taken each year it is evident that the pressure increased more rapidly than the yield. This relationship is expressed in the decline in the average number of fish caught per hour. There are many interesting implications in this relationship. For instance, it is improbable that the decline in the average number of fish caught per hour is wholly due to reduction in the available trout by angling. It is probable that this value is also influenced by the appearance of less expert anglers, and by the increase in disturbance along the stream because of the presence of more people. While all these elements must be considered, one cannot evaluate their relative importance because of inadequate data. It may be significant that many brown trout have been seen well distributed in the stream following the close of the fishing season. There has also been a considerable amount of natural spawning by brown trout each fall. Again, it should be emphasized that the fish were free to leave this area.

CONCLUSION

The section of Augusta Creek under study seemingly has been improved for trout fishing by changing the management policy to include stocking of brown trout instead of brook trout. While the temperature appeared to be within the range usually regarded as suitable for brook trout, other ecological factors evidently were not

suitable. The silting of the bottom resulting from erosion in the water shed may have been a factor although the brook trout did not respond to the installation of deflectors, wing dams, and similar stream alteration devices. The stream alteration devices did, however, result in a change of qualitative and quantitative relationships of the aquatic insect populations.

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MINK FEEDING EXPERIMENTS: REPORT I

By H. F. TRAVIS, R. E. HOWELL, A. C. GROSCHKE, and C. G. CARD
SECTIONS OF ZOOLOGY AND POULTRY HUSBANDRY

THE COMMERCIAL rearing of mink is a relatively new kind of animal production. Obviously, many of the problems encountered bearing on nutrition are as yet unsolved. At present one of the major difficulties of the industry is to find feeds that will suit the dietary requirements of the animal and at the same time remain inexpensive so as to make mink farming a profitable business. Horse meat, once the staple of the ranch mink diet is becoming increasingly scarce and expensive. By-products from the meat packing, poultry, and commercial fisheries industries are being tried as mink feeds with some success. Other workers are trying to find economical and balanced diets, using standard feeds developed for other domestic and farm animals. This trend toward using feeds that are unnatural to mink has led to increased nutritional problems for the mink rancher.

OBJECTIVES

The objective of the present study was to design a "complete" diet, composed of a variety of easily procured ingredients, which when fed as the sole source of food would support growth and maintain a good state of health in mink. Should this objective be achieved it would lead to a considerable saving in feed costs, labor costs in preparing diets, and overhead costs for refrigeration and grinding equipment now needed to store and handle fresh animal products. It would also afford a more stable situation in regard to feed supply.

PROCEDURE

Six adult mink and fifteen kits were used in this experiment. The kits were offspring of five different litters and were weaned at about 7-8 weeks of age. The adults were one year old. All the animals were

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maintained under ranch conditions[1] and were confined individually in screened wire cages. Food was offered each evening, and water was constantly available. Weighings were made at one-week intervals. Prior to initiation of the experiment all animals were fed a ranch diet (Table 3).

On July 31, 1948, at an average age of 85 days, 15 kits were divided into 5 groups of 3 kits per group and started on their experimental diets. The composition of the basal diet is shown in Table 1. In addition to the 5 kit groups, 2 groups of adult female mink of 3 animals per group were also placed on experiment. A transition period of one week was allowed while the animals were gradually changed from the ranch diet to their new diets. Although the basal diet was a dry mixture, each portion of food was moistened with enough water to make it of a hamburger consistency which seemingly is more palatable to mink.

Three periods, occurring in succession, were involved in this study. The first period of 69 days' duration was intended to measure the adequacy of the basal diet for supporting growth. Various supplements in combination with the basal diet were also tried in an effort to bring to light any deficiencies which might have existed in the basal mixture. The supplements employed were fresh horse meat, fresh liver, Wilson's liver powder 1:20, and a vitamin mixture. The vitamin mixture supplied to each 100 grams of dry diet the following amounts of vitamins (in milligrams): thiamin Hcl 0.2, riboflavin 0.4, pyridoxine Hcl 0.2, calcium pantothenate 1.5, niacin 4.0, choline chloride 100.0, folic acid 0.05, biotin 0.01, alpha tocopherol acetate 0.5, and menadione 0.1.

TABLE 1—*Experimental mink basal diet No. 1*

	Percent
Ground yellow corn	30.0
Rolled oats	20.0
Corn flakes	15.0
Soybean oil meal	10.0
Fish meal	5.0
Meatscraps	5.0
Wheat germ oil meal	5.0
Homogenized fish	2.0
Blood meal	2.0
B-Y feed (500 micrograms riboflavin/gram)	2.0
Dehydrated alfalfa leaf meal	2.0
Ground limestone	1.0
Salt (iodized)	0.5
Fish oil (400D, 2000A)	0.5
Manganese sulfate—10 grams/100 pounds	
	100.0

ANALYSIS—Moisture 9.49%, ash 7.15%, protein 22.88%, ether extract 2.86%, fiber 2.56%, nitrogen-free extract 54.75%.
Analysis made by Dr. E. J. Benne, Department of Agricultural Chemistry.

[1]This feeding experiment was conducted on the mink ranch of Mr. Paul N. Sandell of Owosso, Michigan.

The second period was of 14 days' duration. The same diets were fed as during the preceding period except that an amino acid supplement of DL methionine, DL lysine, and DL tryptophane was fed. Table 2 shows the composition of the amino acid mixture. In each instance where this mixture was used it was added at the expense of the basal diet and at a level of 1 percent of the total diet. At this level it supplied 0.2 gram of DL methionine, 0.25 gram of DL lysine, and 0.30 gram of DL tryptophane to each 100 grams of total diet.

The third period was of 28 days' duration when all the animals except one group of adults were returned to the ranch diet (Table 3).

RESULTS

The design of the experiment and results are given in Table 4. In period 1 (July 31-October 7) all kits in the experimental groups lost weight at a time in their life cycle when they should have been gaining rapidly. Less loss of weight was experienced, however, in the two groups which received fresh meat (groups 2 and 3). The feeding of supplemental vitamins and vitamins in combination with liver powder did not improve the basal diet (compare groups 4 and 5 with group 1). Kits 11, 12, and 13 lost a high percentage of their body weight and were unable to survive on their dietary regimes. In the adult animals maintenance of body weight was achieved where the basal diet alone

TABLE 2—*Composition of amino acid mixture*

	Percent
DL Methionine	20.0
DL Lysine	25.0
DL Tryptophane	30.0
Corn meal	25.0
	100.0

TABLE 3—*Composition of ranch diet*

	Percent
Horse meat	65.0
Canned fish (Atco)	10.0
Cereal (Kellogg's Hexite)	9.0
Fresh liver	10.0
Conkey's Y-O	1.0
Skimmilk powder	2.0
Tomato puree (canned)	2.5
Fish oil (400D, 2000A)	0.5
	100.0

TABLE 4—*Comparison of weight gains on experimental diets*

Group	Mink No. and sex	Period 1			Period 2			Period 3		
		69 days—July 31-Oct. 7			14 days—Oct. 7-Oct. 22			28 days—Oct. 22-Nov. 19		
		Diets	Weights (gm)	Percent gain or loss	Diets	Weights (gm)	Percent gain or loss	Diets	Weights (gm)	Percent gain or loss
Kits										
1	1 F	Basal	575 366	−36.3	Basal	366 316	−13.66	Ranch Diet	316 640	+102.53
	2 F		586 439	−25.1		439 435	− .91		435 525	+ 18.39
	3 M		740 606	−18.1		606 546	− 9.90		546 460	− 15.75
2	4 F	60% Basal 40% Horsemeat	575 572	− .51	Same diet plus amino acid mix	572 596	+ 4.20	Ranch Diet	596 780	+ 30.87
	5 F		584 456	- 21.9		456 475	+ 4.16		475 642	+ 35.15
	6 M		755 705	− 6.6		705 826	+17.16		826 1000	+ 21.06
3	7 F	50% Basal 40% Horsemeat 10% Fresh liver	626 515	−17.7	Same diet plus amino acid mix	515 565	+ 9.70	Ranch Diet	565 727	+ 30.79
	8 F		600 477	−20.5		477 565	+18.44		565 705	+ 24.77
	9 M		745 740	− .67		740 865	+16.89		865 1020	+ 17.91
4	10 M	Basal Plus vitamins	671 505	−24.7	Same diet plus amino acid mix	505 572	+13.26	Ranch Diet	572 962	+ 68.16
	11 M		419 Died Sept. 1	−35.32		.....	.....		.....	.....
	12 M		756 Died Sept. 1	−40.47		.....	.....		.....	.....
	13 M	Basal plus	545 Died Oct. 7	−30.09	Same diet	.....	.....	Ranch Diet	.....	.....
5	14 M	Vitamins plus 0.2% Wilson's liver powder 1:20	880 685	−22.2	plus amino acid mix	685 760	+10.94		760 1075	+ 40.79
	15 F		600 420	−30.0		420 416	− .95		416 670	+ 61.05
Adults										
6	16 F	Basal	576 605	+ .50	Basal	605 573	− 5.28	Basal	573 555	− 3.14
	17 F		561 557	− .71		557 609	+ 9.33		609 630	+ 3.44
	18 F		552 575	+ 4.16		575 550	− 4.34		550 583	+ 6.00
7	19 F	90% Basal 10% Fresh liver	662 595	−10.01	Same diet plus amino acid mix	595 634	+ 6.55	Ranch Diet	634 737	+ 16.24
	20 F		462 335	−27.5		335 Died Oct. 13	.....		... ...	.....
	21 F		503 610	+21.27		610 676	+10.82		676 925	+ 36.83

was fed (group 6), while the feeding of a 10 percent fresh liver supplement was of questionable value (group 7).

Inasmuch as the initial period demonstrated that the basal diet alone was a failure, and that weight losses were slightly less where fresh meat was fed, while no such effect was observed with the feeding of vitamins, it appeared that a protein deficiency was the principal defect of the basal diet. The feeding of the amino acid mixture in period 2 (October 7-October 22) shows quite strikingly that this assumption was correct. It will be observed that in all cases but one (kit 15) the supplement of methionine, lysine, and tryptophane reversed the weight losses and promoted significant gains. This is in contrast to continued body weight declines in the kits which were kept on the basal diet (group 1). The adult mink, on the other hand, still appeared to maintain the greater portion of their body weight on the basal diet (group 6). The amino acids appeared to have a slight growth stimulating effect on adult mink (group 7) although one animal died during this treatment (adult number 20). The amino acids were discontinued as a supplement after 14 days because the supply was nearly exhausted.

In the third period (October 22-November 19) all of the animals, with the exception of the adults in group 6, were placed on the ranch diet. Weight recoveries were immediate in all animals except kit 3 which continued to lose weight throughout the period and finally died one week after termination of the experiment. The animals in adult group 6 continued to show their ability to maintain their body weight on the basal diet.

During the course of the experiment four animals died (3 kits and 1 adult). The results of the autopsies as made by Dr. R. A. Runnels, of the Department of Animal Pathology, are as follows:

Animal No.	Days on Experiment	Diagnosis
Kit 11	32	General emaciation, hemorrhagic enteritis, fluid-filled cardiac sac. Primary cause of death probably dietary.
Kit 12	32	Same diagnosis as Kit 11
Kit 18	69	Primary cause of death probably dietary; terminal cause pneumonia and hepatic hemorrhage.
Adult 20	75	Hemorrhagic gastro-enteritis.

DISCUSSION AND SUMMARY

It is evident from the results of this study that the basal diet employed was inadequate for promoting growth in young mink although the diet did appear able to maintain body weight in adults over a period of 111 days. The principal defect of the diet was shown to be concerned with protein and, specifically, with the amino acids methionine, lysine and tryptophane. It is possible that only one of the amino acids or a pair of them was involved, however. This is the first time to our knowledge that a feeding trial with mink has suggested that one or more of the three amino acids mentioned are required for growth in mink.

It should be pointed out that the major proportion of protein in the basal diet was contributed by ingredients of plant origin. Since plant proteins are characteristically low in lysine, tryptophane and to some extent methionine, the predominance of poor quality proteins in the basal diet was no doubt largely responsible for the poor results. Other factors may have been involved too, however, such as low digestibility and unpalatability. The latter factor is an important problem to deal with in future work because several of the animals in this study refused much of their feed apparently because of dislike for the diet.

In work planned for 1949-50 the information gained from this initial and exploratory feeding trial will be of considerable value in formulating a new basal diet which will emphasize ingredients of high digestibility, good palatability, and good protein quality. It is our belief that the development of a complete, dry-type diet for mink, such as are now prepared for a variety of our domestic animals, is not beyond reach and that through further research this goal can be achieved.

ACKNOWLEDGMENTS

We wish to express our gratitude to Merck and Company of Rahway, New Jersey, for crystalline vitamins; to Lederle Laboratories, Inc., of Pearl River, New York, for folic acid; to Dow Chemical Company, Inc., of Midland, Michigan, for amino acids; to Dr. H. R. Hunt, Head of the Zoology Department of Michigan State College, for suggestions and administrative aid during the course of the experiment; to members of the Michigan Fur Breeders Association for supplying the mink; and to Mr. Paul Sandell of Owosso, Michigan, on whose ranch this experiment was conducted.

PACKING-HOUSE TREATMENTS OF MICHIGAN PEACHES

(A Progress Report of Further Trials to Improve Market Quality)

By H. A. CARDINELL[1] and C. GUINN BARR[2]

Section of Horticulture and Food Machinery and Chemical Corp.

During the past several years Michigan State College has participated in studies to maintain longer market life of the best peaches that the industry has been able to produce. About half of the shipments, on which reports have been made, were delivered, sold and consumed or processed, with high praise for the product. This seems to be the case for the entire nation as judged by a recent report (11) of 2,258 carlots of peaches that were inspected out of 40,000 carlot arrivals in the world's largest market, New York City. During that eight-year period (1935-42) 1,129 carlots showed no decay worth noting. The other 1,129 inspected cars averaged 3.8 percent decay. Why some shipments are marketed without loss and other shipments develop an appreciable loss is a problem that baffles the peach industry.

So many factors are involved in growing, harvesting, grading, packing, transporting and merchandising each year's peach crop that all cannot be studied at any one time or place. Michigan, like other peach-producing states, has continuously experimented to reduce peach spoilage and to increase the reputation of the product.

In 1947 the first test shipments of Michigan peaches that had been hydro-cooled with ice-water and a germicide, were reported (3). The test was made possible when the Millburg Growers Exchange installed a patented machine known as a "Stericooler".[3] They treated and

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[3]The "Stericooler" is a patented device designed to drench produce with ice-water in which a germicidal agent may be incorporated. When the water is maintained at 32° F. (0° C.) produce loses about 40 degrees of field heat in 10 to 20 minutes, as it is conveyed through the machine, shown in Fig. 1.

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Fig. 1. The Millburg Growers Exchange near Benton Harbor, Michigan, pioneered the introduction of the Stericooler in 1947, for hydrocooling and treating Michigan peaches for better quality. This view shows peaches being fed from the packing line into the Stericooler in 1948, where a time-geared conveyor carries the product through a cascade of antiseptically treated, 32° F. ice-water. The base holds ice-water. The metal shaft and electric motor shown at the mid-section on the right, provide the means to lift about 1900 gallons of chilled water a minute to the header-box at the top from whence it is spread over a perforated metal ceiling plate. Along the metal shoot shown in the doorway at the left is fed ice from the ice-sizer and elevator into the tank of water.

shipped 7,128 packed bushels that season and in 1948, 8,792 bushels of peaches were put through their Stericooler. In the 1947 studies, the effectiveness of this new process was compared with the common packing-house practice of dusting the fruit with sulfur as it is "de-fuzzed" in the brushing machine. All of the tests for the control of peach decay were made after a lapse of 7 and 11 days after the fruit was packed, in order to simulate the effects of long-distance shipments and cold storage holding.

In the season of 1948, the Coloma Fruit Exchange, as well as the

Fig. 2. During the 1947 season no facilities were considered for storage of ice. In 1948 a small ice station was used, but it was scarcely adequate. It was, however, very conveniently placed near the Lilly ice-sizer and elevator, the other side of which is shown in Fig. 1.

Millburg Growers Exchange, both located in Berrien County, Michigan, treated a large portion of their pack in their Stericoolers. This afforded the authors an opportunity to conduct several studies and obtain records on many carlot and trucklot shipments. In cooperation with the Agricultural Economics Department, a post card requesting information was inserted in nearly 20,000 bushels of packed peaches. The replies by retailers and housewives on the condition of Michigan peaches have been published elsewhere (5).

STERICOOLING REDUCED ICING IN TRANSIT

The two packing-houses treated 22,680 bushels of the 1948 pack of peaches in their Stericoolers. The remaining portion was brushed and dusted with sulfur and was not precooled before loading.

Fig. 3. A view of the 1948 installation at the Coloma Fruit Exchange, Coloma, Michigan. This was nearly an ideal installation. The F.M.C. Stericooler was placed on the dock outside the packing room. On the roller conveyor in the foreground packed bushels of peaches come from the packing lines. The machine holds 48 baskets under treatment. Fifteen minutes later the first baskets are pushed by the conveyor onto the drain apron at the opposite end. There pads and covers are put on, wired securely and the baskets go by conveyor into pre-iced freight refrigerator cars. The motor-driven chain-conveyor in the left foreground at the bottom of the picture is a return line to the cold storage room, when cars are not available or when sales are slow. Trucks can also be loaded at the end of the platform. Ice is stored in a freight refrigerator car near the ice crusher.

Through the cooperation of the railroads, the Railroad Perishable Inspection Agency and refrigerator-car lines, the authors have reports on the icing record and condition of produce on arrival of 66 carloads of peaches shipped by rail from Hartford, Sodus, Watervliet, Coloma and Benton Harbor, Michigan, during 1948.

From these records it has been possible to compare identical shipments. Some cars carried only Stericooled peaches. Other cars were loaded on the same date with peaches that had been given the usual sulfur dusting at the time of grading, but were loaded warm into pre-iced refrigerator cars.

The next logical question of interest to shippers and receivers would be, "How much re-icing would be saved by loading Stericooled fruit?"

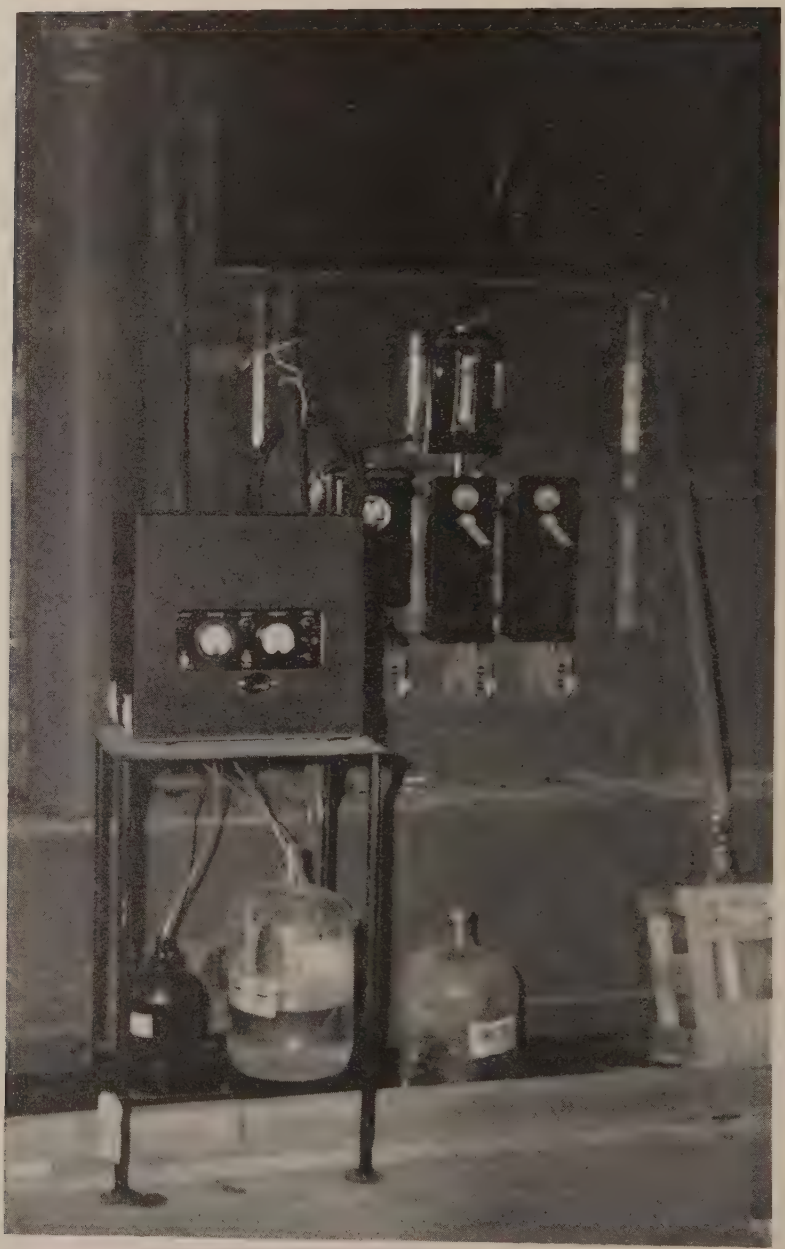

Fig. 4. A broadside view of the F.M.C. Stericooler at the Millburg Growers Exchange, Millburg Station, Benton Harbor, Michigan, in 1948. In 1947 the strength of the germicide, Hypo-Clor, was determined at intervals by manual titration color tests. In 1948 an electric sampling and pumping unit shown on its stand in the center foreground, was used. This view shows the lower tank portion of the Stericooler where 1,950 gallons of water are stored.

Fig. 5. This picture was taken at the close of the 1948 peach season. It shows an ideal installation of a Stericooler on the car loading platform at the Coloma Fruit Exchange. The produce enters through the door at the left from the packing lines, travels through the machine and emerges at the right where it is lidded, wired and conveyed to railway cars, trucks or into the cold storage rooms. The ice elevator may be seen at the right.

The temperature of the peaches throughout the 1948 season averaged about 85° F. (range, 69° to 93° F.). When the packages emerged from the 32° F. hydro-cooling water, the fruit averaged about 45° F. (range, 37° to 50° F., depending on fruit temperature). It was natural to assume that 45° F. fruit loaded into a pre-iced refrigerator car or truck would require less total refrigeration than for 85° F. fruit. How much this saving might be, would be only a guess.

Of the 66 carlots, only 6 cars loaded with Stericooled peaches could be matched in lapsed time between departure and destination with 6 cars loaded with brushed and sulfur-dusted fruit. Each car contained 396 bushel-baskets of peaches.

Details of the six Stericooled cars shipped under standard refrigeration and comparable data on six warm loaded cars are given in Table 1.

From Table 1, it is clear that precooling peaches in a Stericooler before loading into iced refrigerator cars saved, in reicing, a difference of 4,459 pounds of water-ice per car, as an average of six cars of each treatment.

TABLE 1—*Comparison of re-icing of stericooled and warm loaded cars.*

Car number	Treatment	Days to destination	Average commodity temp. °F	Re-icing, Lb.	Decay
Warm loaded, sulfur-treated shipments, Benton Harbor to New York City, 1948					
MDT 40923....	Check (loaded warm)	4	42(43–40)	12,100	1%
MDT 5610.....	"	4	47(50–44)	12,200	2%
SFRD 4491....	"	4	43(46–40)	15,050	none
MDT 24104....	"	6	42(44–40)	15,200	−1%
MDT 3504.....	"	7	44(46–41)	19,900	−1%
SFRD 25514...	"	8	44(46–41)	14,550	1%
			Total re-icing...	89,000	
Average.....	"	5½ days	44°F.(43.7)	14,834	
Stericooled shipments, Benton Harbor to New York City, 1948					
MDT 22638...	Stericooled (Hydrocooled before loading)	4	44(47–40)	9,000	none
MDT 43269....	"	4	44(47–41)	8,650	none
FGE 30079....	"	4	41(42–39)	12,000	1%
FGE 36542....	"	6	44(47–40)	10,000	none
BRE 75653....	"	7	41(40–38)	11,500	1%
MDT 3202.....	"	8	42(44–40)	11,100	−1%
			Total Re-icing	62,250	
Average.....	"	5½	43°F.(42.9)	10,375	
	Difference in favor of Stericooling			4,459	

No record is available as to whether any or all of the cars loaded with warm peaches were fan-precooled. All cars were shipped as "standard refrigeration plus 3-percent salt".

Stericooling or any other method of precooling before the produce is loaded into a refrigerated carrier, saved many hours of time as compared with precooling after the carrier was loaded with warm produce. It saved fan-precooling time and cost of $15 per car, which, with the saving of an average of 4,459 pounds of water-ice per car in transit helped materially to defray the cost of Stericooling the produce before loading. Above all, precooling before loading assured rapid and uniform cooling of every package at the time of loading, plus the advantage that accrued from the addition of an antiseptic.

THE COST OF STERICOOLING IN 1948

The Stericooler has been available either on a service-rental basis or by purchase. Detailed cost items are given in Table 2.

The two units in Michigan have been installed on a seasonal basis at a charge of 8 cents per bushel to offset equipment and installation

TABLE 2—*Calculated cost of stericooling peaches, 1948*

Packing-House No. 1

Peaches Stericooled, 8,792 bushels		Cost per bushel
Ice used, 161,450 lb. (18.3 lb. per bu.), or	$ 564.39	$0.064
Extra electric power and labor used	$ 87.92	0.010
Processing cost: (Chemicals, maintenance, depreciation, interest)	$ 703.36*	0.080
Total cost	$1,355.67	$0.154

Packing-House No. 2

Peaches Stericooled, 13,888 bushels		Cost per bushel
Ice used, 246,000 lb. (17.7 lb. per bu.) or	$ 854.17	$0.061
Extra electric power and labor	$ 138.88	0.010
Processing cost: (Chemicals, maintenance, depreciation, interest)	$1,111.04*	0.080
Total cost	$2,104.09	$0.151

*The Stericoolers used in Michigan were leased on the basis of a full season's use of a minimum number of bushels treated. Neither packing house was able to treat sufficient bushels to meet the minimum use rate; hence, their actual costs were higher than those shown in this table. The costs used in these calculations were those that would have been possible had the users had sufficient volume of peaches to reach the contract usage rate. The cost could have been lower than shown in this table had the volume of produce treated been greater than the minimum contracted rate.

costs, including, interest, depreciation, insurance, maintenance and supervision. This charge also covers the cost of the germicidal agent, Hypo-Clor,[4] apparently of considerable benefit in counteracting the build-up of spore-load in the ice-water recirculated over the produce.

In washing apples to remove spray residue, Fisher and Reeves (7) studied the "Influence of Washing on Storage Rots". They stated that, "Large numbers of fungus spores are removed from the apples and accumulate in the solutions during the washing process."

It can be assumed that when recirculating ice-water as a refrigerent, peach spores are likewise certain to accumulate unless some germistatic means is used to reduce spore activity.

Employing cultures of Rhizopus rot (Rhizopus nigricans) Slade (10) has shown that conditions similar to those produced by Stericooling were very effective in retarding the growth of this organism.

Barr and Slade (1) have called attention to the heat of respiration generated by peaches at varying temperatures. From the viewpoint

[4]A patented brand of chlorine-type compound.

of precooling, they compared air precooling with water precooling and state, "Since this is a much faster method of cooling than the conventional methods of cooling with air, cooling with the Stericooler is accomplished at a much greater rate of speed. Roughly, one minute in the Stericooler is equivalent to one hour of normal air cooling."

In tests in California with cling and freestone peaches of processing maturity, Link and Pancoast (8) report on tests made between hydrocooling with germicidal ice-water as compared with common refrigeration in brine-cooled air. These investigators report that, "The total increase in yield of antiseptic cooled fruit over conventionally handled peaches varied from 10 to 15 percent of fruit stored from 3 to 4 weeks at 32° F. In addition, the yield of treated fruit not requiring hand trimming increased about 10 percent over fruit not so treated. For antiseptic cooling, about ½ pound of ice was required to cool 1 pound of fruit from about 80° to 40° F."

This type of packing-house equipment is new to Michigan, and neither packing house had adequate facilities to store and handle ice economically, hence, considerable wastage took place. Future users of ice can make many economies in hydrocooling produce by placing such equipment near low temperature storage rooms where ice may be held without meltage. Otherwise, ample insulated storage space should be provided near the Stericooler. Retired refrigerator cars may be useful in this connection.[5]

Another point in packing-house management that could greatly reduce the cost is the provision of a steady supply of peaches once the packing crew is assembled and the 1,950 gallons of water in the Stericooler is cooled to the desired temperature each day.[6]

Packing houses prefer to pack peaches as fast as they arrive from the orchards. The result of this practice has been that peaches are being packed only about one half of each day except for a few peak days each season. This is a problem for each packing house to solve, if it so desires. It is of interest to the authors in that it is a large factor in the total cost of any packing-house operation such as Stericooling. For example, on many days the machine was refrigerated, only to be shut down after a few hundred bushels had been Stericooled. Thus many tons of refrigeration were wasted that had to be charged against only the actual number of peaches treated.

[5]Refrigerator Cars as Farm Storages. Special Bulletin 308, Mich. Agr. Exp. Sta., East Lansing, Mich.
[6]There are several sizes of hydrocoolers on the market. Those used in Michigan were the large size.

Perhaps the best solution of the entire cost of packing and treating such produce would be to "stock-pile" one or two days' supply of peaches before starting the packing season. If this is one of the answers to lower cost, it may call for immediate brushing and dusting or Stericooling of peaches against rot development, as fast as the peaches arrive at the packing house and then conveying them into 30 - 32° F. holding rooms. They could later be packed when enough fruit was on hand to guarantee continuous full-day operation. Some such procedure would afford full-day runs and occasionally half-night or all-night operation, when sales exceed the packed supply. Under California conditions it is reported (8) that, "This process adds to the efficiency and economy of plant operations. Because the treated products may be stored longer than untreated material, a regular schedule of operation is possible. A backlog of raw products, maintained in an original condition of quality, makes possible a flexible plant operation and largely eliminates from the production schedule such variables as weather and breakdowns."

Virtually all of the Stericooled fruit from Southwest Michigan in 1947 and 1948 was shipped to distant markets. The method of rapid cooling described herein quickly removed the field heat, retarded the rate of post-harvest ripening and aided in the prevention of spoilage losses. High quality fruit resulted in increased marketability at its destination and buyers apparently felt justified in paying from 25 to 75 cents per bushel premium for Stericooled peaches.

RESULTS OF PACKING-HOUSE TREATMENTS IN 1948

After the rush of the peach pack began to lessen, 23 packed bushels of Elberta peaches were purchased from one of the fruit exchanges in Berrien County. The peaches had been picked on the afternoon of September 16 and were brushed, dusted with sulfur and packed the following morning, September 17. They were marked U.S. No. 1, 2″ Min.

In order to divide the fruit into more samples it was transferred into "Jumbo" baskets, each holding about 50 peaches. This afforded an opportunity to remove all specimens that were much riper than the average, as well as those that were bruised or showed signs of split-pit, worm or rot. This second grading eliminated five bushels of peaches from the original 23 packed bushels, and should have resulted in a more uniform lot of peaches for the trials. These were as follows:

1) The peaches from 18 baskets were treated by being dipped for 15 minutes in tapwater, containing 100 p.p.m. of Hypo-Clor.

2) Those from another 18 baskets were treated by being dipped for 15 minutes in ice-water at 32° F.

3) Fruit from another 18 baskets was treated in a Stericooler. Water temperature was 32° F.; Hypo-Clor was used at 100 p.p.m., for 15 minutes.

4) That from another 18 baskets was dusted with dusting sulfur at the time of brushing and packing.

After this fruit was so treated it was trucked to Michigan State College and placed in storage at 32° F. until each examination period.

It was decided to remove a portion of the fruit from each treatment and determine the relationship of rot development 1) to peach treatment, 2) time in cold storage and, 3) hours out of storage at 75 - 85° F. The results are presented in Tables 3 and 4.

Table 3 shows a comparison of the four treatments as lots I, II, III and IV (column 1) and groups I and II (column 2) represent date of removal from storage and hours at room temperature. Indicated also are the percentages of unrotted and rotted fruit and their respective pressure determinations, indicating firmness of flesh, 96 hours after removal from cold storage on September 21. Also shown is the amount of loss from rot in older fruit only 48 hours after removal from cold storage on September 25.

This illustrates two very important points, long known to investigators, fruit inspectors and most fruit buyers but seldom recognized by retailers and consumers, that a) fresh fruit ripens continuously, even at 32° F., and b) rot-causing organisms are, likewise, developing in infected fruit. The colder the temperature the slower is the activity.

PEACH RIPENESS AND PRESSURE-TESTS

Table 3 represents the examination of 1119 peaches. The fruit of Group I of each treatment was removed from cold storage on the evening of the fourth day, September 21. Twenty-four hours later, when the fruit had approached the temperature of the packing room, a test of the firmness of these peaches was made by means of a standard Ballauf[7] plunger-type pressure tester and a 5/16-inch point. In making

[7]D. Ballauf Mfg. Co. 621-H. Street, Washington, D. C.

TABLE 3—*Elberta peaches treated against rot, 1948*

Column	1	2	3	4	5	6	7	8	9	10
	Relation of time in storage to time out of storage									
Treatment	Lot number	Group number	Sound fruit number	Sound fruit percent	Fruit rotted number	Fruit rotted percent	Total fruit number	Date removed from cold storage**	Hours at 75°F.	Days since harvest
Tap-water plus Hypo-Clor* at 100 p.p.m.	I	I	115	71.0	48	29	163	9/21	96	9
	I	II	100	68.0	50	32	150	9/25	48	11
	Pressure-test after 24 hours out of cold storage, 15.98 pounds Pressure-test after 96 hours out of storage, 4.95 pounds									
Ice-water (32°F)	II	I	105	71.0	42	29	147	9/21	96	9
	II	II	99	67.0	51	34	150	9/25	48	11
	Pressure test after 24 hours out of cold storage, 15.98 pounds Pressure test after 96 hours out of cold storage, 5.50 pounds									
Stericooled (32°F) ice-water plus Hypo-Clor* at 100 p.p.m.	III	I	120	81.0	29	19	149	9/21	96	9
	III	II	112	75.0	38	25	150	9/25	48	11
	Pressure test after 24 hours out of cold storage, 15.98 pounds Pressure test after 96 hours out of cold storage, 4.95 pounds									
Brushed and dusted with sulfur	IV	I	108	76.0	34	24	142	9/21	96	9
	IV	II	108	73.0	40	27	148	9/25	48	11
	Pressure test after 24 hours out of cold storage, 15.98 pounds Pressure test after 96 hours out of cold storage, 5.29 pounds									

*Hypo-Clor is the name of a brand of a chlorine-type compound.
**Fruit was harvested Sept. 16, 1948 and packed and placed in cold storage the following day.

TABLE 4—*Elberta peaches treated against rot, 1948*

Column	1	2	3	4	5	6	7	8	9	10
	Relation of lapsed time to treatment and control									
Treatment	Lot number	Group number	Sound fruit number	Sound fruit percent	Fruit rotted number	Fruit rotted percent	Total fruit number	Date removed from cold storage**	Hours at 75°F.	Days since harvest
Tap-water plus Hypo-Clor* at 100 p.p.m.	I	III	144	97	5	3	149	9/28	000	12
	I	IV	132	92	13	8	145	9/28	24	13
	I	V	66	69	30	31	96	9/28	48	15
	I	VI	39	39	61	61	100	9/28	96	17
	I	VII	20	19	85	81	105	9/28	144	19
					Average	37				
Ice-water (32°F)	II	III	187	97	6	3	193	9/28	000	12
	II	IV	135	92	12	8	147	9/28	24	13
	II	V	46	54	39	46	85	9/28	48	15
	II	VI	23	22	80	78	103	9/28	96	17
	II	VII	20	19	83	81	103	9/28	144	19
					Average	43				
Stericooled (32°F.) ice-water plus Hypo-Clor* at 100 p.p.m.	III	III	148	98	2	2	150	9/28	000	12
	III	IV	126	89	16	11	142	9/28	24	13
	III	V	55	63	33	37	88	9/28	48	15
	III	VI	54	58	40	42	94	9/28	96	17
	III	VII	28	29	69	71	97	9/28	144	19
					Average	33				
Brushed and dusted with sulfur	IV	III	143	98	3	2	146	9/28	000	12
	IV	IV	128	92	11	8	139	9/28	24	13
	IV	V	52	59	36	41	88	9/28	48	15
	IV	VI	26	26	75	74	101	9/28	96	17
	IV	VII	16	17	77	83	93	9/28	144	19
					Average	41				

**Hypo-Clor is the name of a brand of a chlorine-type compound.
*Fruit was harvested Sept. 16, 1948, and packed and placed in cold storage the following day

the test small areas of skin were sliced away in four places on each test peach. A reading was taken on either side of the suture and one on either "cheek" or side of the peach. An attempt was made to select peaches for the pressure test that represented the full range of maturity of the entire lot. The average of the pressure tests was 15.98 pounds and represented a range of 3 to 30 pounds. Four days later at 75° F. a similar pressure test was taken and showed an average test of 5.17 pounds, with a range of 4.95 to 5.50 pounds.

Four days after the fruit was removed from cold storage, on September 25 an examination of 601 peaches revealed that 25.3 percent of the fruit of all treatments was rotted.

On September 25, the ninth day of storage, fruit of Group II (Table 3, column 2) was removed from cold storage and after 2 days at 75° F. examination showed that an average of 29.5 percent of the fruit had rotted.

This may be one of the many reasons why some buyers are often reluctant to buy peaches that have been held in cold storage several weeks. In the study previously mentioned (11), where federal inspection was made in New York City on 2,258 carlots of peaches, the report states that, "Decay was most prevalent (10.0 percent) in peaches from California, some decay being reported in 88 percent of the carlots inspected from that state; most of it was due to brown-rot . . . ; decay in fruit from states other than California ranged from 1.0 to 1.9 percent." Much of the heavy loss was doubtless due to the eight- to ten-day haul before the fruit was unloaded in New York.

Nearness to market is truly a measurable factor in the reduction of peach rot. Peaches grown in New York State and having a short haul to New York City, were shown to have only 0.2 percent rot. Of infected cars showing decay, Maryland peaches had only 0.4 percent, whereas Arkansas peaches showed 2.6 percent decay and Georgia peaches had 1.9 percent decay. Michigan did not have enough carlots inspected in New York City to be included in the study, but very likely it might be expected to fall somewhere between Ohio's 1 percent and Illinois' 1.3 percent decay. Receiving point inspection was obtained on 12 carlots of Michigan peaches shipped from Benton Harbor, Michigan, to New York City. Regardless of the fact that these cars were not inspected until the 4th, 6th, 7th and 8th days after leaving their point of origin, an average of less than 1 percent decay was reported under federal inspection (Table 1). The fruit was packed at Hartford, Millburg, Coloma and Sodus and should represent a cross-section of south-

western Michigan peaches. Also, it was grown and shipped during a near-record year for severity of brown-rot. Here is proof that the first eight days under refrigeration showed the least loss. The subsequent spoilage prior to consumption is reported elsewhere (5).

Table 4 represents a comparative study of treatments based on examination of 2,364 fruits for peach rot, made at intervals of 0, 24, 48, 96 and 144 hours after removal from cold storage in 1948. In this case all the baskets were removed from cold storage the evening of September 28. After 12 days at 32° F. the fruit would have been classified by the trade as hard-shipping maturity. An average of 80 punctures of peeled flesh of 20 peaches by means of a 5/16-inch point on a standard pressure-tester, showed a firmness of 16.4 pounds.

With Group III (Table 4, column 2), the number of peaches injured by rots were counted within 2 hours after removal from cold storage. An average of 2.5 percent rot had occurred after 12 days in cold storage. Twenty-four hours later, the fruit of Group IV (column 2) showed an average of 8.5 percent rotted fruit. This was an increase of 6 percent rot in 24 hours. By the time the fruit of Group V had been out of cold storage 48 hours, the average of all treatments was 38.8 percent rot. After 96 hours, rots had increased until 63.5 percent of the fruit was involved. On the sixth day (144 hours) out of storage, rots had accounted for an average of 78.5 percent of the peaches of Group VII (column 6). It should be remembered that this fruit had been graded twice to make it more uniform.

Table 5 shows, by treatment, the average percentage loss due to peachrot from the 12th through the 19th day after harvest.

In the 1947 study (3) the germicidal agent, Hypo-Clor, was used at 130 p.p.m., whereas, in 1948 it was used at 100 p.p.m.

Table 5 is a summary of the average of each group number (from Table 4, column 2), repersenting the number of hours out of storage as shown in column 9, for each treatment.

TABLE 5—*Summary of the average loss by rot, 1948. Treatment in relation to lapsed time*

	Average rot loss groups III to VII (Ave. 12 to 19 days after harvest)
	Percent
Lot I—Tap-water plus "Hypo-Clor" at 100 p.p.m.	37.2
Lot II—Ice-water (32°F)	42.6
Lot III—Stericooled (ice-water 32°F. plus Hypo-Clor at 100 p.p.m.)	32.6
Lot IV—Brushed and dusted with sulfur	41.2

Lots I and III were treated alike, in that they contained a like amount of the same germicide. Since these treatments showed the lowest amount of waste from rot, it indicates that some benefit resulted even from the 12th to the 19th day after harvest. The treatment given Lot III (Stericooled) produced the best results, as was true in 1947. It seems to have been due primarily to the germicide rather than to the hydrocooling, since hydrocooling alone, shown as Lot II, gave the poorest control. This is logical, since hydrocooling provided refrigeration for only a few hours. It is interesting to note that tap-water (60° F.—Lot I) plus the germicide gave slightly better average (37 percent rot) control of peach rot than did hydrocooling alone (43 percent rot—Lot II). The brushed and sulfur-dusted treatment, the standard procedure against rot in most packing-houses, ranked third and was only slightly better than hydrocooling. In similar trials made in 1947 (3) it is notable that the Stericooled fruit showed much better results without further refrigeration than was indicated by comparable packs, which were dusted at the grader with sulfur and "Zerlate" and, likewise, given no refrigeration.

In both seasons the limited tests strongly indicate that the prophylactic treatment with the chlorine compound reduced loss from rots far more effectively than did dusting sulfur.

Peaches that stood in ice-water, containing no germicide, until they reached a temperature of 44 - 46° F. had the highest percentage of rot. This bears out the findings of Brooks and Cooley (2) more than 20 years ago, that, "Wetness probably also hastened germination and facilitated infection." A fungicide appears to be essential before or after the packing operation, regardless of subsequent temperature.

This is a long way from perfect protection but the 5- to 10-percent better control, 12 to 19 days after harvest, is a welcome adjunct to marketing better peaches. Better germicides may be discovered, and much stronger strengths of the same germicide may prove safe on peaches.

UNEVEN MATURITY IN PEACH PACKS

It is quite common to hear or read references to "marketing problems" and "production problems." It is seldom simple to separate one from the other. As a matter of fact, many of the problems in marketing can mainly be corrected on the farm and in the packing house. Likewise, many production problems can be solved on the farm if it could be assured that markets would pay for the improvement or

change. These statements apply readily to fruit-sizing, grading, packaging and to such treatments as Stericooling.

One very disturbing factor that has not been given sufficient consideration is the matter of uneven maturity in almost any package of peaches.

From commercially packed bushels of Michigan Elberta peaches, the authors selected at random several bushels to be placed in cold storage and brought out at intervals for examination and testing by means of a standard Ballauf piston-type pressure tester.

The fruit, as previously stated, had been picked on September 16 1948, was packed on the following day, and placed in cold storage at 32° F.

After being in cold storage 5 days until September 21, one lot was allowed to attain the temperature of the packing room for 24 hours, which was 56° F., night average and 62° F. day average. On September 22, six days after harvest, 10 peaches were tested for firmness. The average of the 40 readings was 15.98 pounds per peach. The range varied from 3 pounds to 30 pounds, or the full range of the pressure-tester scale.

Of the 10 peaches, 5 showed readings much below the others. These five had a range of 3 to 15 pounds, with an average of 8.9 pounds. The test readings of the firmest five averaged 23 pounds.

Another lot of Elberta peaches was held at 32° F. for 12 days after being packed. Ten peaches were tested at random. Of the 40 readings the average was 19.2 pounds pressure to puncture the flesh. Three peaches indicated, by the color of the skin, that they were much more mature than the other seven. Their average was only 4.8 pounds. Except for the three specimens the remaining seven peaches averaged 25.4 pounds, obviously, very hard peaches even after 12 days in cold storage.

The final lot was removed from 32° F. cold storage after 13 days and was held at 75° F. room temperature for 2 days. After this treatment the peaches were soft ripe and showed an average pressure-test of only 3.7 pounds. Of this lot, one peach was much firmer than all the others. It tested 6.3 pounds. This last lot had reached the stage considered by most home canners as ideal maturity for peeling. Except for the one firmer peach, the rest were near the minimum pressure recordable by the pressure tester.

These pressure tests were taken in connection with other treatments and, therefore, a study of the degree of firmness as related to

spoilage was not a part of this study. The pressure tests, however, show that a certain proportion of firm-ripe shipping peaches become mixed with a lot of the very hardest fruit. It is, therefore, easier to understand why, after several days, in transit, in storage and in warm stores that a portion of the softer fruit may become bruised and infected long before the hard specimens have reached even the "firm-ripe" stage. Perhaps it is the contact between firm fruit and the soft and diseased specimens that allows premature infection of hard, green peaches, even in cold storage.

In connection with these trials, it has already been stated that market appraisal of peaches so treated was obtained by inserting approximately 20,000 post cards in packed bushels. The replies from 944 dealers and housewives have already been reported. (5)

That study, among other items, reveals the seriousness of the problem of packing peaches of various degrees of ripeness within the same package, as expressed by the dealers and housewives who reported the condition. The study indicates that, "In the case of peaches rated as 'too-ripe', the average waste was one-fourth, while in the case of peaches rated 'about right,' less than one-tenth was reported as the average waste. The greatest amount of bruising was found in peaches which customers marked as being 'mixed-ripe and green.' In the case of peaches classified as being 'mixed-ripe and green' the amount of bruising was almost double the average given for each of the four other groups. This mixing of peaches of different degrees of ripeness in the same containers appears to greatly aggravate bruising."

SKIN-COLOR AND PRESSURE TESTS

As one observes fruit rolling, hour after hour, into the packers' bins after being sorted for size, it becomes evident that there are several degrees of maturity going into each package.

In 1947, Elberta peaches were separated by sight into four degrees of color as indicated by the ground-color or the non-red pigment portion of the skin of each peach. After dividing the fruit into four color groups, each group was tested for firmness of the peeled flesh by means of a pressure-tester with a 5/16-inch point. These tests are shown in Table 6.

The peaches were separated into four classes in the order of apparent ripeness: 1) leaf green, 2) greenish-yellow, 3) sulfur yellow and 4) amber yellow. As a guide to color, the "Peach Harvest Color

TABLE 6—*Firmness of flesh as related to color of skin, Elberta*

Skin color (under-color)	Trade terms	Pressure test when packed average pounds	Pressure test after 7 days at 75°F. average pounds
1. Leaf green	Green	28	14
2. Greenish-yellow	Hard-ripe	22	13
3. Sulfur yellow	Firm ripe	18	9
4. Amber yellow	Tree ripe	13	6

Standards" used by Coe in Utah (10) were used in the Michigan studies.

All of these peaches had passed the persons who were sorting in accordance with the standard of the packing house. These peaches, except the few bushels taken out for this test, went into commercial packs. In fact after this lot had been packed, 25 bushels were purchased and used in the treatments.

The pressure tests verified the degrees of maturity that the eye detected. In general, the greener the under-color of the skin the firmer was the flesh beneath the skin. This ratio was not only true at the time of packing but also 7 days later at "store" temperature.

The solution of the vexing problem of grading fruit to a more uniform separation of firmness is by no means easy, on a low-cost commercial basis. Perhaps it cannot be rapidly done, economically, until electronic color graders can be perfected. In the meantime trained fruit pickers can do the most in picking the ripest fruit first and keeping it separate from the firm-ripe and hard fruit. Packing houses try to separate grower loads as to ripeness, but it is little short of impossible to separate peaches of varying maturity once the fruit reaches the sorting belt. This appears to be a problem that only supervised picking can now correct.

The conclusions reached by Morris reporting on a five-year study on "Peach Maturity at Harvest as Related to Quality" can scarcely be better stated on the question of determining color and firmness. He reported in 1932 (9) that, "Pressure tests cannot be used independently of other methods in determining harvest dates or selection of fruit to be picked. They can often be used to determine the color standards for each picking. At any one date from the beginning of the picking season, peaches of extreme hardness and extreme softness may be found on the same tree attached to the same type of twigs located in the same sections of the top. . . . *A combination of pressure*

tests and color seems to be the best method of arriving at a standard or gauge to use in harvest work. . . . Adequate maturity of peaches is necessary for the attainment of highest quality. Complete maturity of the fruit before picking will prevent its shipment to distant markets without heavy loss. The fruit that is still hard and green when harvested will endure rough handling in packing and will show less picking and shipment injury than the fruit of more advanced maturity. The green fruit, however, is of very inferior quality when ripened, and is unattractive for use even when soft enough for eating out of hand or for culinary purposes." This problem is continually being investigated.

A study of, "factors other than palatability which are important in determining acceptability of peaches", was reported in 1948 by Cravens and Paul (6). They stated that, "These data confirm, in general, the judges' conclusion that tree-ripe peaches were superior for 4 days after harvest, and firm-ripe peaches were better for storage periods of 6 to 9 days. The firm-ripe peaches did not develop the attractive external color of the tree ripe peaches, while the hard-ripe peaches were still quite green at the end of the storage period."

On the question of flavor, texture and color those authors state that "The qualities scored were those considered by the housewife in determining the acceptability of any given lot of peaches. . . . The results indicate that the tree-ripened peaches were much more acceptable at 2 days after harvest than were the firm-ripe or hard-ripe ones.

At 4 days, the tree-ripened peaches were still slightly more desirable than the firm ripe peaches. Six days after picking, the firm-ripe peaches were more acceptable than the tree-ripe, and as acceptable as the tree-ripe peaches had been at 2 or 4 days. At 9 days the quality of the firm-ripe peaches was again highest. At no time did the quality of the hard-ripe peaches equal that of either tree-ripe or firm-ripe peaches."

DISCUSSION AND SUMMARY

From a casual review of the extensive literature pertaining to the causes of spoilage of peaches in transit and in marketing, it is evident that many factors are involved. Seemingly, there are two periods for attacking the causes of decay. One is the control of brown-rot fungus through a complete program of orchard sanitation and adequate protection by applications of spray material. The other is through careful harvesting of fruit of uniform maturity and quick and adequate

refrigeration and, if possible, coating all surface of the fruit with an approved and safe fungicide. Very likely the sooner the harvested fruit is treated and subjected to 30 - 40° F., the more effective should be the preventive treatment.

The other zone is primarily in the packing house, in transit and until peaches are consumed or processed and is directed against black-mold rot (Rhizopus) and blue-mold rot (Penicillium) as well as against brown-rot spores. Spray materials applied in the orchard seemingly have no effect against these two post-harvest diseases, black-mold and blue-mold. Thirty years ago it was stated, "With all the rots, temperature has been an extremely important factor. . . . Rhizopus (black-mold rot) was entirely eliminated at the lower temperature (41° F.) and Penicillium (blue-mold rot) and Monilia (brown-rot) were greatly reduced" (3).

These three diseases of harvested peaches can only be prevented and arrested by the quickest possible refrigeration, once the fruit is off the tree. Germicidal treatments appear to be most beneficial against decay after fruit leaves refrigeration.

The packing-house treatments herein reported were attempts to measure the effectiveness and cost of rapid pre-cooling by hydro-cooling. The results 4 to 8 days later in carlot shipments of fruit Steri-cooled before loading were contrasted with identical shipments of uncooled fruit, dusted with sulfur.

Since most shipments under adequate refrigeration show very little decay at destination it was necessary to obtain replies from retailers and housewives, who purchased Michigan peaches treated in these tests. This was done by inserting a consumer post card in some 20,000-bushel packs from three packing houses, two of which operated a Stericooler and one used only sulfur dust in the defuzzing unit. The authors of the market phase of the study (5) comment, "The variation in waste reported by buyers of both Halehaven and Elberta peaches showed a wide variation. Almost two-fifths of the buyers reported less than one pound of waste per bushel due to rot. On the other hand, one-fifth reported 20 percent or more waste due to rot. Such wide variation in waste due to rot suggests the need for more information concerning methods now used for controlling rot. *If one-third of the peaches can be marketed with no more rot than one pound per bushel it should be possible for more to be as successfully grown and handled by the same methods.*"

The tests in 1948 showed a marked saving in the amount of ice used between Benton Harbor, Michigan and New York City, when freight refrigerator cars were loaded with Stericooled peaches. Loading hydrocooled fruit saved the time and the $15 per car cost of fan-precooling on-track before shipment. This can be important as was demonstrated more than 21 years ago (2) when it was found that, "*nearly 60 percent of the damage done by Monilia (brown-rot) during the given transit periods (ave. 6 days) in either the top or bottom of the car was accomplished during the first 36 hours after the car was closed.*"

In the Michigan studies (Table 4) the fruit samples from commercial packs were treated in 1) tap-water plus germicide, Hypo-Clor, 2) ice-water, 3) ice-water plus Hypo-Clor (Stericooling) and 4) sulfur dusting of warm fruit. In the work of 1947 (3) and in 1948 can be seen the apparent good results of even 100-130 p.p.m. of the chlorine-type germicide, Hypo-Clor, with or without refrigeration. It also indicates that once removed from low temperature, decay sets in rapidly (Table 4, column 6) regardless of previous treatment. Hydrocooling with Hypo-Clor (Stericooling) at 100 p.p.m., in 1948, resulted in 10 percent better control of decay than did hydrocooling with ice-water without the Hypo-Clor. These results were obtained after all the fruit had been in cold storage for 12 days and out of storage from 1 to 5 days (Table 4, column 9).

This study also illustrates the relation of time (age of fruit) and temperature to peach spoilage, regardless of treatment. The results indicate that search should continue for more efficient fungicides and germicides that are safe to use on food.

It should be noted that the fruit used in these experiments had been grown in one orchard. It was under soil cultivation, well pruned, sprayed with a "speed-sprayer" and, in-short, nothing was spared that the most experienced owner could approve. It was picked in the afternoon, hauled to the fruit exchange in the evening and the next morning it was put through the defuzzer and dusted with dusting-sulfur, passed before a sorting crew of 16 women, sized mechanically and packed "face and fill." From this lot on the packing-house floor, the authors purchased 23 bushels. While separating this fruit into smaller, 15 pound baskets, 5 bushels of fruit were removed to eliminate over ripe, crushed, wormy or rot-infected fruit that had escaped the eyes of the sorters.

Regardless of this double sorting, there were too many "ripe" peaches mixed with "green", hard fruit. After five days in 32° F. cold storage, one lot was removed from storage and after approaching the temperature of the room, pressure readings showed that the average of the fruit was 15.98 pounds. Half of the fruit was softer than the other peaches and the soft ones averaged 8.9 pounds. The remaining firmer fruits averaged 23 pounds of pressure to crush the peeled flesh. The former peaches were suited to a short haul or short storage life, whereas, the hard-ripe fruit, after 5 days in storage could, no doubt, have been shipped across the continent and been highly merchantable, so far as firmness was concerned.

Though incidental to this study of some commercial packing-house procedures, the retailer and consumer replies associated with this study have been published in a previous report (5). That report states, "In the case of peaches rated "too ripe", the average waste was one-fourth, while in the case of peaches rated "about-right", less than one-tenth was reported as the average waste. The greatest amount of bruising was found in peaches which customers marked as being "mixed-ripe and green."

Plans have been made to continue certain phases of these complex peach marketing problems during the 1949 season.

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PROTECTING PLANTS FROM FROST INJURY THROUGH THE USE OF RADIANT ENERGY

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THE FARMER who is growing a crop that is subject to injury from frost and who is considering the practicability of measures to ward off that injury needs to know as much as possible about: 1) the minimum temperature that is to be expected and its duration, 2) the danger point for the plant at the particular stage of its development, and 3) the cost of possible control measures, weighed against probable financial loss should no control be attempted. Unfortunately each one of these main elements that enter into the situation is influenced by a number of factors and the best that can be done is to make some estimates that it may be hoped are reasonably accurate.

WHAT TO EXPECT IN THE WAY OF MINIMUM TEMPERATURE

Weather Bureau predictions are not infallible, but where they are available they represent the most reliable information covering wide areas. It must be remembered, however, that such predictions are for wide areas. They are not intended to apply to any particular farm or field or even a particular valley or township. The farmer's knowledge of how his own particular conditions generally vary one way or another from those characterizing the whole area covered by the forecast will have to guide him as to what to expect. A low-lying field with poor air drainage may experience a temperature several degrees lower than the area as a whole and 10 degrees lower than a near-by site with exceptionally good air drainage. Temperatures of air surrounding a low-growing crop such as strawberries or cantaloupes may be 2 to 6 degrees lower than those of the air surrounding the blossoms or fruits of adjacent tree fruits. Temperatures within a few inches of a soil with

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a moist surface may be 2 or 3 degrees higher than those just above a similar soil whose surface has dried out. A wind movement of even 2 or 3 miles per hour will cause considerable difference in temperatures close to the ground, as compared with a perfectly still atmosphere. A temporary dip to a critical point is far less serious than the same temperature that is held for hours. Thus it is necessary for the farmer to interpret the Weather Bureau's prediction, estimating or judging what to expect on his own land and under his peculiar conditions.

CRITICAL TEMPERATURES

Unfortunately (or fortunately) there is no single critical minimum temperature for all plants. Nor is there a single critical temperature for any one kind of plant. Some kinds are relatively hardy and others are relatively tender. Cabbage, carrots and cauliflower are classed as hardy to frost (tolerant of temperatures in the low twenties, at least when well hardened); tomatoes, cantaloupes and egg plants are classed as tender (likely to be injured by temperatures below 32° or 31° F.) However, cauliflower is less hardy than carrots and tomatoes are less tender than cantaloupes. Tomatoes will withstand a lower temperature following a period of cool weather than they will following a warm, more favorable growing period. Dormant peach flower buds are less resistant to freezing in midwinter (-15° F. usually resulting in considerable killing) than are those of either the sour or sweet cherry (often surviving -20° to -25° F.) The reverse is true in either in their late preblossoming and full bloom stages (peach blossoms often withstanding 26° to 27° F. while 28° to 29° is dangerous for sweet cherries). Apple blossoms are killed by temperatures that peach blossoms will survive; but peach fruits just before harvesting are seriously injured by temperatures substantially above those that leave apple fruits uninjured. Blossoming of the strawberry plant is spread over a considerable period, and the critical minimum temperature for the early blossoms is essentially the same as that for the late ones. However, destruction of the early blossoms by frost is far more serious than destruction of the late ones, in view of the fact that the largest and best berries are always produced from the early blossoms.

From these statements it will be seen that it is just as necessary for the farmer to know approximately the minimum temperature that certain crops he is growing will withstand at a given time without injury as it is to estimate closely the minimum temperature that will

be registered. Two or three hours' protection some one night in the spring when the trees are in bloom might save his apple crop and be entirely unnecessary with his peach crop and a similar amount of protection as the fruit is approaching harvest in the autumn might save the peach crop and be unnecessary with the apples. If the procedure were reversed, both crops would be lost, though the cost of protection would have been the same. Protection from frost injury during a single night might yield big dividends with a variety of tomato or sweet corn that matures early while the price is high and be worth very little with a midseason or late maturing variety.

PROTECTION OF TOMATOES AND STRAWBERRIES

Experience with commercial infrared heating units operating under controlled conditions on two major crops, tomatoes and strawberries, indicates that this type unit when properly used is quite effective in the protection of low-growing crops.

During the fall of 1948 three units were used in a group for protection of tomatoes on the Michigan State College farm. The results were reported in detail in the Michigan Agricultural Experiment Station Quarterly Bulletin Article 31-37 (Feb. 1949).

A summary of the findings at that time is that the tomatoes were protected quite effectively to a temperature of 26° F. over an area of about a half-acre per machine. The protection at temperatures around 29° F. was considerably greater, being about 0.7 acre per machine. Tomatoes are very sensitive to frost damage and are one of the most difficult to protect.

Each of the machines required about 10.5 gallons of kerosene per hour of operation.

The protection furnished by the machines was sufficient that in a year of early frosts in the fall, the increased income to a farmer through the use of the machines might well be $100 to $150 per acre.

Strawberries are an important crop to many farmers in southwest Michigan. One of the principal hazards in the growing of this crop is the frosts which occur throughout May and substantially reduce the yield. During the spring of 1949, tests were conducted to determine the performance of the radiant-type frost protection unit on this crop. An opportunity was also afforded to field test recent improvements in the design of the oil burner used in this machine.

BURNER IMPROVEMENTS

The burner which was used for the field test was one which had more stable burning characteristics and could be operated on kerosene or No. 1 fuel oil. The improved burner, Fig. 1, became an integral

Fig. 1. Both the air and fuel can be controlled on the improved burner. The generating coil is enclosed in the emitting chamber.

part of the machine and both air and fuel supply could be regulated. A number of checks made on the consumption of fuel showed that it consumed approximately the same quantity of fuel as the machines earlier in use.

PROCEDURE

A farmer in Van Buren County, near the village of Keeler, was selected as cooperator for this project. Four machines having the improved burner were installed in the center of a field of strawberries, May 9, 1949. The units were placed in a quadrangle having sides of 140 feet with the shorter diagonal being 156 feet. The strawberries were of the Robinson variety, in the second year of production, and had not been mulched.

TEMPERATURE MEASUREMENTS

Recording thermometers which have the coil-type sensitive unit were installed at two locations outside the influence of the infrared radiation. The sensitive units were suspended about one inch above the ground and a calibrated mercury thermometer was placed in close proximity to check periodically the accuracy of the recording apparatus. Nocturnal readings being the only interest, no attempt was made to shade the sensitive units from the sun during the day.

TEMPERATURES DURING FROST PERIODS

The first damaging frost occurred on the morning of May 11, when the temperature dropped below 32° F. at 2 a. m. and did not rise above that mark until 6:15 a. m. The lowest temperature was 21° F. which was recorded for a 45-minute period. This was a rather severe frost for this time of year inasmuch as the mercury was below 26° F. for the duration of 2 hours. All strawberry blossoms which had not received sufficient protection in this field were completely destroyed.

Cold weather did not come to the area again until the evening of May 24, when the thermometer registered 32° F. at 11:15 p. m. The lowest recorded temperature was 27° F. for a 15-minute duration. The temperature did not go above 32° F. until 5:30 a. m. May 25.

Two days later, May 27, the temperature dropped momentarily to 30° F. at 10:30 p. m. and warmed up until 2 a. m., May 28, when it went below 32° F. for a 3½-hour duration. The lowest recorded temperature, 28° F., was recorded for a period of one hour.

The last frost of the season visited the area on the following evening, May 28. This was not a severe frost, for the temperature did not drop below 29° F. but it lasted for a period of 8 hours and 15 minutes.

A summary of the temperature data is as follows:

Date	Hours below 32° F.	Period below 32° F.	Min. Temp. °F.
May 11	4 ¼ hrs.	2:00 to 6:15 a.m.	21°
May 24 and 25	6 ¼ hrs.	11:15 p.m. to 5:30 a.m.	27°
May 27	¼ hr.	10:30 p.m. to 10:45 p.m.	32°
May 28	3 ¼ hrs.	2:00 a.m. to 5:30 a.m.	28°
May 28 and 29	8 ½ hrs.	10:00 p.m. to 6:30 a.m.	29°

OPERATION OF THE INFRARED FROST CONTROL MACHINES

The four frost control machines were started at 1:15 a. m., May 11, when the 3 M.P.H. northwest wind subsided to a drift and the temperature was 34° F. They were operated for 4¾ hours, during which time the temperature dropped to 21° F., outside the protected area. They were not shut off until the temperature had raised to 33° F. Substantial protection was realized out to a distance of 45 feet with noticeable saving of blooms out to 50 feet. Many blossoms which were in a position to receive the infrared energy were saved from the frost out to a distance of 60 feet from a single radiation unit. Most of the blooms beyond this distance from the machines were destroyed.

Figure 2 shows the appearance of the blossoms in the unprotected check area beyond the influence of the machines a few hours after the frost.

Figure 3 shows the appearance of the blossoms in the protected area a few hours after the field in general had been exposed to a temperature of 21° F. It will be noted that the infrared radiation of proper intensity was very effective in protecting the blossoms even against this low temperature.

It might be assumed from the temperature data recorded during the frost periods that the machines were operated each time when the temperature was below 32° F., but this was not the case. The cooperator had regarded the thermometer on his back porch, some 2000 feet from the location of the experiment, as infallible and that temperatures recorded at this point would not be too much different from the field temperatures. He reports that he reached the field about 2:00 a. m. on the morning of May 25, long after frost had formed. Realizing that the damage had been done, it was his desire to determine whether it

Fig. 2. Strawberries in the check area beyond the influence of the infrared, were killed by the frost, causing the center of the blossoms to turn black.

Fig. 3. Strawberries receiving a sufficient intensity of infrared radiation were protected against a temperature of 21° F. Note light colored centers indicating live blossoms.

would benefit the strawberries to operate the machines. It was for this reason that he turned on one machine at 2:00 a. m. and turned it off at 6:00 a. m. after the temperature had gone above the freezing mark. Observations the following morning showed that the crop was not benefited by such a move, because of the fact the damage had occurred prior to operating the machine.

This inaccurate method of taking temperatures gave the cooperator the mistaken belief that frost was not covering the field during the next two recorded periods, May 27 and 28, when actually the temperature was below 32°.

OBSERVATIONS AND COMMENTS

The greatest single factor for the failure of any frost control device was pointed out by this experiment. The operators must be trained to make accurate temperature readings in the field and at the *crop level.* Actually the blossoms which had been carried through the May 11 frost, plus the blossoms which were able to endure the three succeeding frosts, were the only ones which developed into friut in the area covered by the frost control machines. The May 24 frost destroyed 73 percent of the blossoms, but it did not injure the fruit, the blossoms of which had been protected by the machines on the morning of May 11. For all purposes, the yield difference between the protected and unprotected areas is the result of one period of operation of the frost control machines on May 11.

Observations made in an adjoining field of heavily mulched strawberries showed that the crop had been retarded 10 days to 2 weeks by the mulch. The mulch forms an insulation and restricts the flow of solar energy to the soil. It would also limit the infrared radiant energy protection which might be afforded during a frost period. An extremely dry layer of soil would create the same situation.

HARVEST CHECKS AND OTHER DATA

The area protected by the frost control machines was marked and harvested separately. A harvest record was also made on an area beyond the influence of the infrared radiation and having similar terrain and cultural treatment. The first four harvest periods showed a marked difference in yields while there was no statistical significant difference in the fifth, illustrating the effectiveness of the frost protection in saving the *early* blossoms and fruit.

Harvest date	Frost control plot, crates per acre	Check plot, crates per acre	Market price per crate
June 7	15.07	0	$5.85
June 9	16.74	1.82	5.00
June 10	21.85	9.32	5.00
June 12	47.93	18.73	4.00
June 14	No significant difference.		

Experience shows that a strawberry blossom which has been destroyed by frost will not be replaced. It was found that the two plots yielded equal amounts after the June 12 harvest.

Subtracting the yields of the unprotected check plot from the plot under the influence of the infrared, it was found that 71.74 additional crates per acre of fruit were obtained due to the protection given by the machines. After deducting the handling costs this resulted in a gross income of $231.87 MORE per acre than from the unprotected area.

SUMMARY OF TESTS ON STRAWBERRIES

1. It has been demonstrated that infrared radiation is very effective in the protection of strawberries against frost damage at temperatures well below 32° F.

2. It has been demonstrated that through the judicious use of the infrared frost control machine a farmer can realize substantially increased yields on a crop of strawberries when frosts occur during the blossoming period.

3. Heavily mulched strawberries are retarded from 10 days to 2 weeks and, consequently, would miss the early high priced market.

4. The improved burner functioned very satisfactorily and consumed somewhat less than 10 gallons of fuel (kerosene or No. 1 fuel oil) per hour.

5. In all frost control work, temperatures must be taken at the crop level and locations, not elsewhere, in order to determine when the frost control equipment should be operated.

GENERAL SUMMARY

The problem of protection of fruits and vegetables from frost damage is one which varies with every crop, and with different topographical conditions.

Accurately controlled tests show conclusively that the infrared

radiant-type frost control method is very effective in protecting low-growing crops such as tomatoes and strawberries.

The area which can be protected per machine of present design will vary with the conditions. On tomatoes about 0.7 acre per machine was protected when the minimum temperature was 29° F. During many years this would be the minimum temperature for which protection would need to be provided. At 20° F. the protection of tomatoes was only for a radius of about 30 feet. On the other hand, with strawberries there was good protection at a 50-feet radius when the temperature was 21° F. and there was some protection much farther.

The question of whether it pays to protect crops with this device, is one which can only be answered by a study of the individual situation. As in the case of strawberries, protection of the early blossoms enables the grower to provide berries for the early market and obtain a high price for his product. Under these conditions, the cost of the protection can be readily justified by the increased returns.

In the fall, the protection of tomatoes, flowers and the like, offers possibilities for good returns on the investment.

If the machines can be used for several crops—and in both the spring and fall, the investment per acre can be reduced and increased profits thereby realized.

The infrared radiant-type frost protection machine is the most positive means known at the present time for large-scale frost protection.

A COMPARISON OF TILLAGE IMPLEMENTS AND THEIR EFFECT ON CROP YIELDS

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THE INTRODUCTION of several new types of tillage machines during recent years has led to a number of questions in regard to the relative merits of different methods of soil preparation made possible by these machines.

There has been much discussion about the advantages of normal plowing compared with rotary tillage where the vegetation is mixed throughout the disturbed soil. Advantages have also been claimed for a type of plowing which loosens the subsoil and mixes part with the topsoil.

The change from animal to tractor power has led in some instances to more soil fitting than may be necessary or desirable; accordingly, some methods of seedbed preparation were included in this study which involved plowing and fitting in one operation.

During the past 3 years several methods of tillage with different machines or combinations of machines have been investigated on two common soil types. The results obtained in these experiments are presented in this paper.

METHODS AND MACHINES

The different methods of tillage and the equipment used in these tests are described below. Except where noted, all plowing was to a depth of 6 inches.

CONVENTIONAL PLOW

A two-bottom plow was used, followed twice over with a double-disk harrow and then twice with a spring-tooth harrow.

On land prepared for oats subsequent preparation consisted of disking only.

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Fig. 1. Plow with sub-bases.

PLOW WITH SUB-BASES

This plow has two bottoms which were set at 6 inches. Below these are two sub-bases which run in the furrows turned by the upper bottoms and which were set to cut an additional 3-inch depth, thereby mixing part of this lower soil with the top layer (Fig. 1).

The subsequent disking and spring-tooth harrowing was the same as for the conventional plow.

CONVENTIONAL PLOW WITH PLOW-PACKER ATTACHED

In this treatment the conventional two-bottom plow was used. Directly attached to this plow was a packer consisting of a series of cast wheels as shown in Fig. 2. This unit covered a strip 28 inches wide and was attached in such a way that it covered the two furrows turned during the previous trip of the plow. The ground received no other preparation before planting, thereby making the tillage a "once-over" operation.

In 1948 a seeding unit was attached to the packer so that the oats were drilled in the same operation as plowing. The entire unit was pulled with a two-plow tractor.

Fig. 2. Two-bottom conventional moldboard plow with plow packer attached, pulled by two-plow tractor.

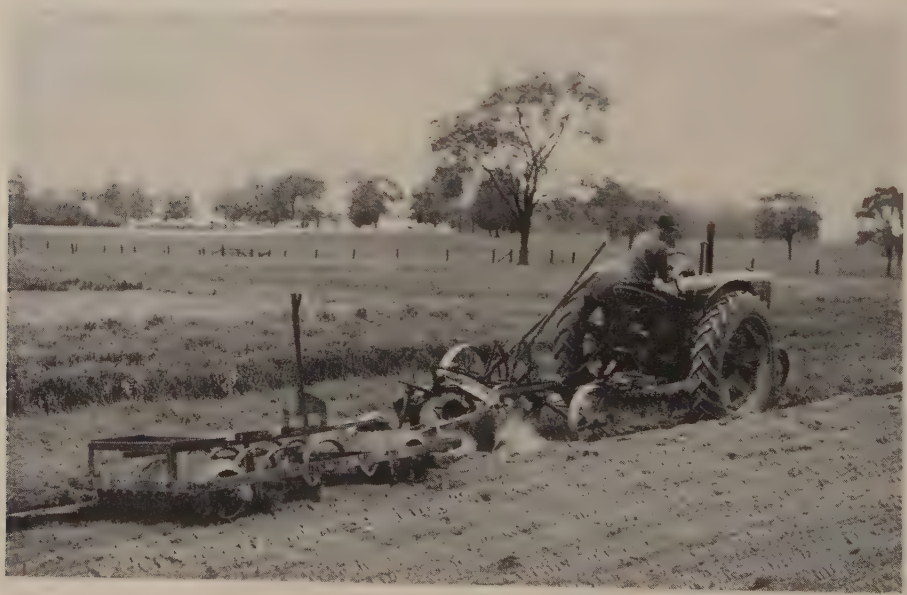

Fig. 3. Two-bottom conventional moldboard plow with mulcher attached, pulled by two-plow tractor.

CONVENTIONAL PLOW WITH MULCHER ATTACHED

The conventional plow was used as above. A mulcher was attached which fitted the soil as it was being plowed. This was also a "once-over" operation which prepared a seedbed ready for planting and was pulled with a two-plow tractor.

The mulcher (Fig. 3) consists of a group of spring teeth preceded and followed by single cultipacker units mounted in a single framework and made to trail beside the plow.

ROTARY-TYPE TILLER

The machine used was a two-wheel walking type with flexible tines (Fig. 4).

Wherever possible the seedbed was prepared by going over the ground once with hook tines to a depth of 6 inches. However, under certain conditions, particularly where there was considerable vegetation, it was necessary to go over the ground two or three times. Under such conditions better results were obtained by working the ground first to a depth of several inches with knife tines and then following with hook tines.

Fig. 4. Rotary-type tiller.

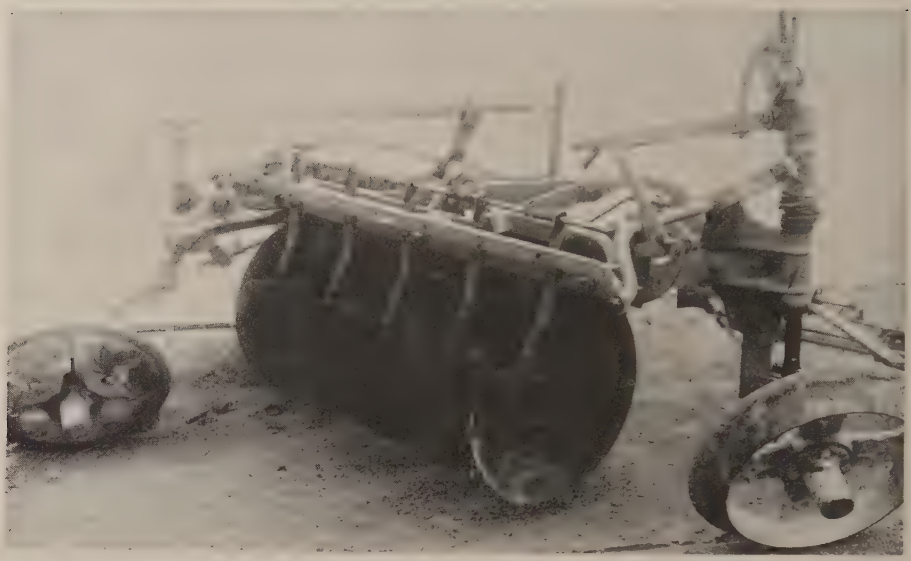

Fig. 5. Vertical disk plow pulled by a two-plow tractor.

Since it was necessary to plant immediately after tillage, the ground was covered once with a standard cultipacker in order to make a firmer seedbed, as the soil was considered too loose at the surface for planting without this added packing.

VERTICAL DISK PLOW

The plow consists of five disks which turn as a unit and were set to cut about 44 inches in width and 6 inches deep (Fig. 5). A full two-plow tractor was used for power.

The subsequent land preparation consisted of disking and spring-tooth harrowing. It was planned to cover the land twice with each unit, but when plowing sod or when the soil was somewhat dry more than two diskings were required to work the surface into a suitable seedbed.

This plow was used in the tests only the past two years.

AUGER-TYPE PLOW

The plowing mechanism consists of a spiral auger mounted horizontally and driven from the tractor power-take-off. A full cut is 28 inches; however, when operated with a two-plow tractor it was possible to take only about a 20-inch cut without overloading the tractor. Figure 6 shows how this machine operated.

Fig. 6. Auger-type plow.

Twice over was usually required and then the penetration was only 4 to 4½ inches. Since the soil was left very loose, a standard cultipacker was run over the surface once before planting.

SOILS AND CROPS

BROOKSTON CLAY LOAM

One set of tests was on Brookston clay loam in Tuscola County, Michigan. The land had been well farmed for a period of years and was in good physical condition. Four different crops were planted each year, namely: corn, sugar beets, oats seeded to sweet clover to be plowed under the following spring, and beans. The rotation was in the order shown above. At the beginning of the experiment the land was in corn stubble.

All the tillage methods described above except the plow and mulcher were used on each crop. The plots were 14 x 100 feet in size, randomized and replicated four times. Thereby, each tillage treatment was on 16 plots per season on this soil.

HILLSDALE SANDY LOAM

A second set of tests which includes all seven methods was conducted on Hillsdale sandy loam on the Michigan State College farm near East Lansing. Plots each 21 x 90 feet were randomized with four replications. It was planned that the rotation would include corn, beans, oats, and alfalfa in the order named. In getting the plots established, however, this sequence was not possible. The field was in brome grass at the start of the experiment. Necessarily then, corn, beans, and oats followed brome grass in 1947. Alfalfa was seeded in the oats but was not harvested in 1947. Corn, planted on the fourth series in 1948 again followed brome grass. Starting with 1949, the crops will fall in their proper sequence.

RESULTS

BROOKSTON CLAY LOAM

The data reported in Table 1 show that on the Brookston clay loam soil, no method of tillage was significantly superior to that which included the use of the conventional plow. The method which included the plow with the sub-bases did result in yields which were higher with all crops than were those obtained where the conventional plow was used, but the differences were not significant.

It is of interest that the yields from the plots where the plow-packer was used were about equal to those obtained from plots which received conventional tillage. This proved to be true despite the fact that some conditions existed which were particularly unfavorable for such a method. In 1947, cultivating was done with a heavy tractor which so depressed the soil between the rows that some of the plants were destroyed. Again in 1948, the oats were planted when the soil moisture

TABLE 1—*Effect of various methods of tillage on the yields of several crops on Brookston clay loam soil*

Tillage method	Yield per acre (average for 1947 and 1948)			
	Beets	Oats	Beans	Corn
	tons	bushels	bushels	bushels
Conventional plow	11.20	88.5	26.3	51.3
Plow with sub-bases	11.40	93.0	29.6	51.6
Plow with plow-packer	10.73	88.9	24.0	52.8
Rotary-type tiller	10.26	89.0	15.3	50.8
Vertical-disk plow	10.99	93.3	25.9	53.6
Auger-type plow	9.42	89.3	19.8	51.3
Difference required for significance	1.07	not significant	8.4	not significant

content was too high for best results with this type of machine. Under such conditions the plow-packer did very little in the way of preparing the soil for the press-drill which followed. Even so, the yields obtained were just about equal to those from the plots fitted in the conventional way.

Oats and corn, in this experiment, followed cleanly cultivated crops where there was no vegetation to work into the soil. Under such conditions, as the data show, the two methods of rotary tillage resulted in yields fully as high as any others in the experiment. In the case of sugar beets, however, where the corn stover had to be worked into the soil, the yield which resulted from the use of the auger-type plow (9.42 tons per acre) was significantly less than where a moldboard plow was used. The yield obtained on the rotary-type tiller plots was also relatively low, 10.26 tons per acre compared with a yield of 11.40 tons where the tillage method included plowing with sub-bases, and 11.20 tons from plots where the preparation was conventional.

The vertical-disk plow plots yielded about the same as those plowed in the conventional manner.

Bean yields were also low where the soil was prepared with either of the rotary machines, probably because it was necessary to work into the soil a heavy growth of sweet clover. Even though the plots were covered two or three times with the machines, it was impossible to do a good job of seeding. Poor stands resulted. Perhaps if several days' time had elapsed between the first and second workings with the machines, better results might have been obtained. This was impossible, however, because plans called for planting some of the plots as soon as they were plowed and to make fair comparisons all plots had to be planted on the same day.

The results obtained on the Brookston soil in 1946 were incomplete since only the conventional plow, the sub-base plow, the rotary-type tiller, and the auger-type plow were compared. When the work started in the spring of 1946, the soil on the entire field was free of vegetation. Under such conditions one might expect about equal results from the different machines. Such was the case, except that the sugar beet yields were slightly higher where the sub-base plow and rotary type tiller were used than were those obtained as a result of the use of the other two methods of tillage.

TABLE 2—*Effect of various methods of tillage on the yields of several crops on Hillsdale sandy loam soil*

Tillage method	Yield per acre				
	Corn		Oats		Oats
	1947	1948	1947	1948	1948
	bushels	bushels	bushels	bushels	bushels
Conventional plow	40.9	25.7	11.8	8.2	53.2
Plow with sub-bases	44.2	20.4	11.4	7.5	51.0
Plow with plow-packer	44.6	32.5	13.4	6.7	53.8
Plow with mulcher	39.7	25.1	13.2	8.1	52.9
Rotary-type tiller	43.4	16.6	10.2	6.4	31.7
Vertical-disk plow	43.0	20.3	9.2	7.6	48.7
Auger-type plow	45.6	20.0	8.9	7.0	38.8

HILLSDALE SANDY LOAM

The experimental results reported in Table 2 were obtained on the College Farm where the soil is Hillsdale sandy loam. The work on that field has been of shorter duration than that on the heavier soil, but certain trends are apparent from the data. Only three crops were grown in 1947. Corn and beans were both planted after brome grass. Where the grass was not turned under much hoeing was necessary to keep the crops clean. Records were kept of the time necessary to hoe each plot. These data are presented in Table 3 and will be discussed later.

Corn yields were not greatly different or affected by the various methods of tillage. In fact, the highest yield was where the soil was prepared with the auger-type plow. The second highest yield was produced on plots where the plow-packer was used. In reality, however, this treatment in the 1947 corn experiment in this field was very similar to the conventional plow treatment because the plots were disked and harrowed after plowing. This was because the particular tractor available did not have sufficient power to make possible the desired weighting of the plow-packer. As a result, the seedbed was not satisfactory for planting without subsequent tillage.

Bean yields in 1947, as shown in Table 2, seemed to fall into three groups. The highest yields were obtained on the plow-packer and mulcher plots, with the poorest results on those plots where the sod was mixed with the surface soil with the rotary and auger-type machines. The yields obtained where the conventional and sub-base plows were used were intermediate. Perhaps these results indicate that the most desirable seedbeds are those where grass and weeds are well covered so they will not compete with the crop, but where the soil is

not too firmly packed. This condition was obtained by the use of either the plow-packer or the mulcher. It is recognized that soils vary in their response to packing, but much evidence is accumulating that excessive packing is detrimental. It may be even more injurious on sandy loam than on clay loam soils, depending perhaps on the nature of the sandy loam and the moisture content of the soils at the time of working. Sandy loams do not contain sufficient clay to cause stable granulation, but some contain enough clay and very fine sand to fill the pores and slow up the movement of both air and water.

In 1948 corn was again planted after brome grass. Where the sod was mixed with the worked layer of soil as with the rotary, auger, and vertical disk type machines, yields were lowest. The comparatively low yield from the plots prepared by the sub-base plow is not in accord with other results in this experiment and cannot be explained. Whenever the sod was turned under with the conventional plow, yields were considerably higher, with the best average yield obtained where the plow-packer followed the plow as a once-over operation and planting immediately followed.

Owing to drought conditions which caused very poor yields of beans in 1948, no valid conclusions can be drawn from the results.

Oat yields in 1948 were reduced by weed competition on the plots which were not turned with the moldboard plow. It is of interest that the yield from the plots where planting was done with the plow-press drill attached to the plow-packer was as high as with any other method of tillage. This conforms with the results obtained on the heavier soil and suggests a way in which farmers might save considerable tillage expense for this crop and also prevent some of the excessive packing which often occurs when oats land is prepared by numerous operations, often conducted while the soil is too wet.

EFFECT OF TILLAGE METHODS ON WEED GROWTH IN BEANS AND CORN

Maximum yields of beans and corn cannot be expected unless weeds are controlled. In 1947 both of these crops were planted on the Hillsdale sandy loam after brome grass. Where the moldboard plows were used, the brome grass was turned completely under. The crops were then planted immediately. Where the planting was done after the plow-packer and mulcher, without subsequent disking or harrowing, grass competition was not severe, as shown by the data in Table 3 and

Fig. 7. Bean plot prepared with conventional plow and attached plow packer (17 days after planting).

Fig. 8. Bean plot prepared with conventional plow and attached mulcher (17 days after planting).

Fig. 9. Bean plot prepared with conventional plow followed by normal tillage (17 days after planting).

Figs. 7 and 8. A little more serious competition occurred where the conventional plowing had been followed by normal tillage, as shown by Fig. 9.

Where the rotary-type tiller, the vertical-disk plow, and the auger-type plow were used, grass competition was very severe as shown by Figs. 10, 11, and 12, and the time necessary for hoeing was much greater than where the moldboard plow was used. The relative time requirements for all the treatments are shown in Table 3.

TABLE 3—*Relative time requirements for hoeing corn and beans after the various methods of tillage*

Tillage methods	Relative time requirement (percentage)	
	Corn	Beans
Conventional plow	100	100
Plow with sub-bases	100	124
Plow with plow-packer	113*	61
Plow with mulcher	74	95
Rotary-type tiller	174	188
Vertical disk plow	171	210
Auger type plow	145	195

*The plots where this treatment was used in 1947 were disked and harrowed after the plow-packer so the treatment was actually similar to the conventional.

Fig. 10. Bean plot prepared twice over with rotary-type tiller followed by cultipacker (17 days after planting).

Fig. 11. Bean plot prepared with vertical-disk plow followed by normal tillage (17 days after planting).

Fig. 12. Bean plot prepared twice over with auger-type plow followed by cultipacker (17 days after planting).

SUMMARY

Several types of tillage machines have been compared on two predominant Michigan soil types. Corn, sugar beets, oats, sweet clover, alfalfa, and beans have been grown.

The machines used in the tests were as follows:

1. Conventional plow followed by normal tillage.
2. Plow with sub-bases followed by normal tillage.
3. Conventional plow with plow-packer attached, a once-over operation.
4. Conventional plow with mulcher attached, a once-over operation.
5. Rotary-type tiller followed by cultipacking.
6. Vertical disk plow followed by normal tillage.
7. Auger-type plow followed by cultipacking.

The information obtained to date may be summarized as follows:

1. Under average soil conditions, where the surface was practically free of vegetation, the yields obtained following the various machines were about the same as those where conventional tillage was used.

2. On the heavy soil the yields resulting from the use of the subbase plow have been slightly higher than those obtained from plots turned with the conventional plow.

3. Where beans have followed sweet clover the yields from soil prepared by the rotary-type tiller and the auger-type plow have been substantially lower than those obtained from other plots.

4. Where crops followed sod, weed control was much easier where the sod was completely turned under than where it was mixed with the surface soil.

5. The "once-over" soil preparation made possible by the plow-packer or mulcher attached directly to the conventional plow seems to offer good possibilities for decreasing cost of seedbed preparation while still maintaining yields comparable with those obtained by conventional methods.

6. Because of the nature of the work, more experimental data are necessary before definite conclusions should be drawn. However, owing to the great amount of interest in these experiments, it was deemed advisable to report the results obtained to date. The project is being continued.

LOCATION CRITERIA FOR OVERNIGHT TOURIST BUSINESSES

By ROBERT W. McINTOSH
TOURIST AND RESORT SERVICE, CONSERVATION INSTITUTE

IN ORDER TO MEET the ever-growing demand for tourist accommodations in Michigan, large numbers of businesses of the overnight cabin type (hereafter referred to as motor courts) have been constructed. They have been built faster and in greater numbers since the end of World War II than at any time in Michigan history. This is relatively new type of business enterprise and no complete, well authenticated library of information has been accumulated regarding it. To a large extent, those entering the business are pioneers—relying on their own native ability and judgment regarding the facilities they are providing. This research has been accomplished for the purpose of giving more complete information on the subject of location. According to one investigator, "The choice of the right location is probably the most important single element in the establishment of a motor court."[1]

The objective of this study is to formulate a specific set of criteria, the use of which will materially assist in judging the desirability of any particular site. Development of a motor court at a location carefully selected in the light of these criteria will likely be more profitable than one not as judiciously selected.

EARLY HISTORY OF MICHIGAN'S TOURIST BUSINESS

Earliest beginnings of touring in Michigan took place on Mackinac Island in 1781 when the British took the island over from the French. Small groups visited the island and later on, following the discovery of iron and copper in the upper peninsula, people came by sailing boat to visit coastal sections of the peninsula, largely in the summer. The first summer resorts in the lower peninsula date back to lumbering times, 1850 to 1890. Lumbermen themselves built resorts as did corpo-

[1]H. B. Love, *Establishing and Operating a Year-Round Motor Court*, U. S. Department of Commerce, 1945, page 1.

rate interests such as railroads and steamship lines. Early resorts were established along the west shore of the lower peninsula at such places as Bay View, Old Mission, and Charlevoix. Resorters came by boat, principally from the larger cities along the Wisconsin, Illinois, and Indiana shore. The larger inland lakes such as Higgins, Burt, and Mullett, had resorts which were started before 1900.[2] Farther south, resorts were built at Onekama, Epworth Heights, Grand Haven, St. Joseph, Union Pier, and Sodus. On the east side of the state, the resorts at St. Clair "Flats," Algonac, and Port Huron were established before 1900.

After the big lumbering days were over, particularly in the northern part of Michigan, the plow did not follow the axe and the land was not producing very much. However, it wasn't long before discouraged men in the upper counties began to realize that these cut-over lands were producing an annual crop—unaffected by drought or untimely frost. It was the vacationist in his Tin Lizzie, snaking his way through the woods on sand trails, usually going hunting or fishing.[3] These early sportsmen started clubs such as the Turtle Lake Club in Alpena county for deer hunters, the Fontinalis Club in Otsego and Cheboygan counties for trout fishermen, and Point Mouillet Club in Monroe county for duck hunters. Many local residents made extra money by accommodating and otherwise serving these sportsmen.

Another early development was the health resort or spa. The first of these began in St. Louis in 1853. Therapeutic qualities of the water drew many visitors as did similar discoveries of mineral water at Spring Lake, Mt. Clemens, and Lansing.

DEVELOPMENT OF THE MOTOR COURT INDUSTRY

Motor courts grew with the development of the automobile industry. The year 1919 was the beginning of the automobile age. It marked the passing of the linen duster, visor cap, and goggles. It marked the beginning of the greatest car and highway building age the world has ever seen.[4] Something had to be done to accommodate the motor campers, and the overnight cabin came into being. The simple one-room cabin has evolved into the modern, completely equipped, de luxe motor court room of today, having tile bath, hot and cold running water and automatic heat. The enormous growth of the auto-

[2]W. O. Hedrick, *The Recreational Use of Northern Michigan Cut-Over Lands*, (Mich. Agr. Exp. Sta. Bull. 247, 1934), p. 37.

[3]Harold Titus, *The Land Nobody Wanted*, (Mich. Agr. Exp. Sta. Sp. Bull. 332, 1945), p. 13.

[4]Franklin M. Reck, *A Car Traveling People*, Automobile Manufacturers Association, p. 8.

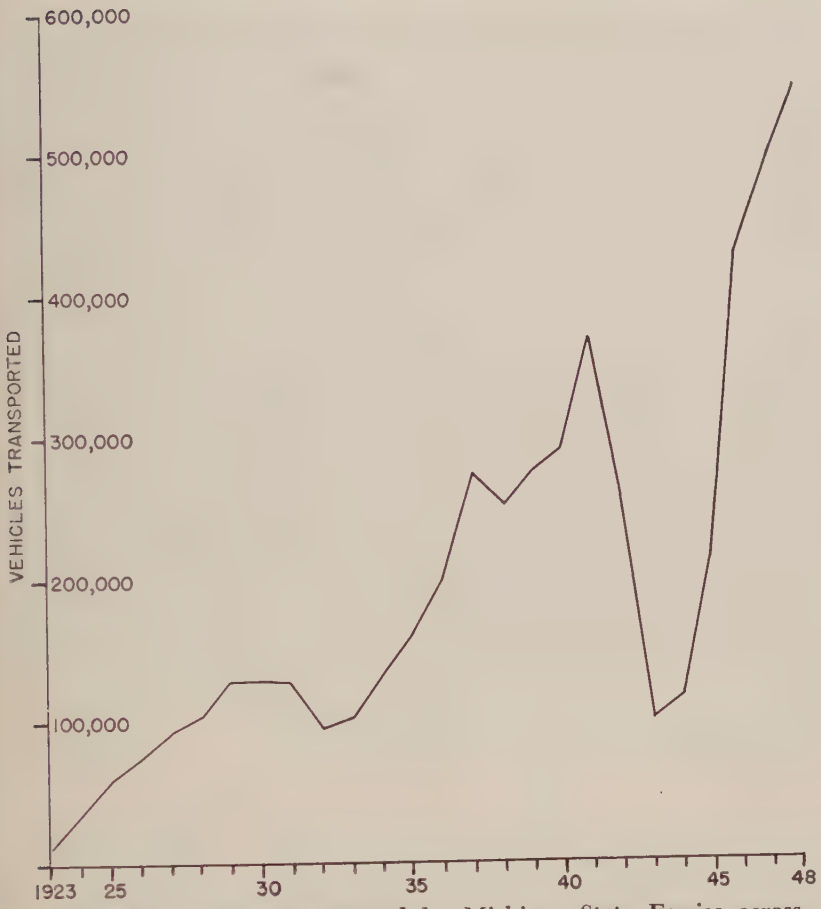

Fig. 1. Vehicles transported by Michigan State Ferries across Straits of Mackinac, 1923 to 1948. (Source: Michigan State Highway Dept.)

mobile industry literally put America "on wheels." There were 4,912 passenger cars built in 1900. In 1948 there were 3,899,665 cars built.[5] In 1922 there were some 600 "tourist courts" in the United States. By 1940, there were 13,521 courts.[6] There will be an estimated 18,000 courts in the country by 1950. Michigan's 1948 tourist business was estimated at $500,000,000.[7]

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[5] *Automotive and Aviation Industries*, January, 1949.

[6] Sixteenth Census of the U. S., 1940, Census of Business, Service Establishments, 1939, pp. 622.3.

[7] Robert J. Furlong, Administrative Secretary, Michigan Tourist Council, personal interview, March 1949.

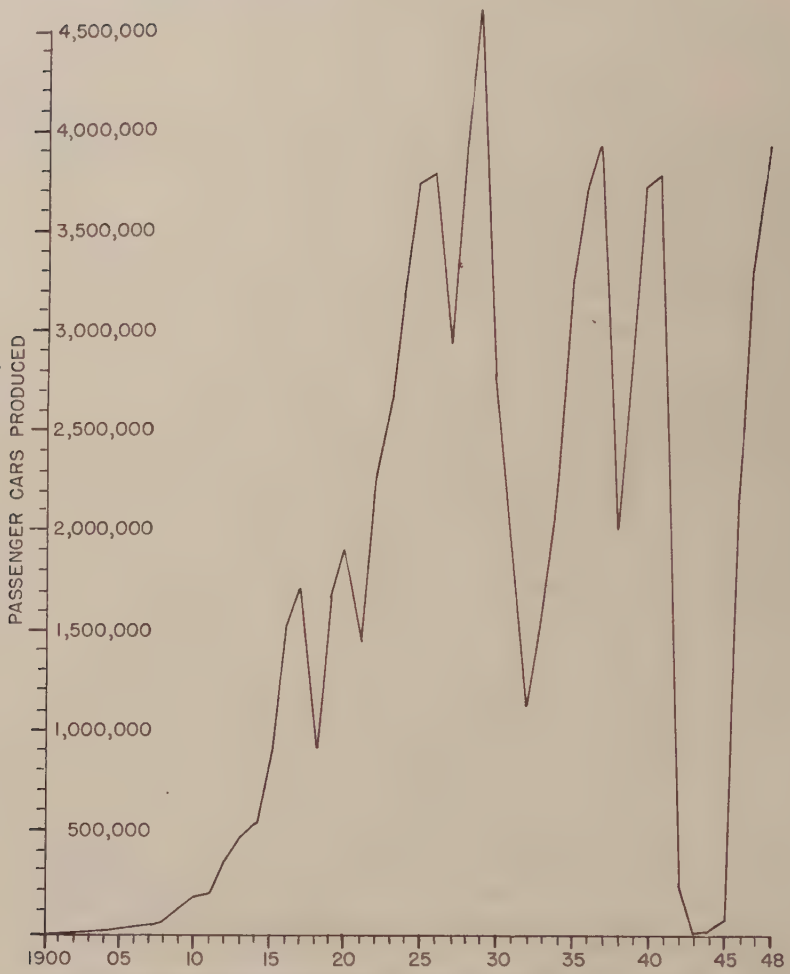

Fig. 2. Passenger car production in the United States, 1900 to 1948. (Source: *Automotive and Aviation Industries*)

LOCATION CRITERIA

The problem of motor court location is considered from three different aspects: the physical, the economic, and the preferences of tourists. A study of the physical aspects of sites was made at several highway bordering locations in the state. During 1947 and 1948, a study was made of the economic aspects of 12 successfully operated motor courts located throughout the upper and lower peninsulas. The guest registers of these establishments were analyzed to obtain data pertaining to origin of patronage (home town) of their guests, size and composition of the registering parties, and the length of their stay. Other aspects

Fig. 3. Early day motor campers had to provide their own "accommodations" for the night.

Photo: U. S. Dept. of Interior

Fig. 4. Today's modern, completely equipped, deluxe motor court.

Photo: Michigan Tourist Council

of the study were enlightened by means of interviews with the operators of the 12 motor courts. Preferences of the vacationing public were obtained by personal interviews with 197 tourist parties as they waited in their cars to cross the Straits of Mackinac.

Physical Aspect of Location—Consideration of soil type, topography, surface drainage, internal drainage, septic tank drainage conditions, suitability for landscaping and lawn growing, is basic in choosing a location.

Economic Aspects of Location—A profitable location must be one that is adaptable to the fundamental economic and human elements, so important in the business of providing overnight accommodations. These are as follows:

Accessibility—The motor court must be easily reached from the highway.

View—There should be a clear view of the court by the passing highway traffic for a distance of at least 1,500 feet. Natural scenic beauty and pleasant view from the court also are desirable.

Permanence—The motor court should be located on a highway which is not likely to be re-routed for 20 years.

Traffic Count—A motor court must be located on a heavily traveled main highway if it is to be profitable.

Length of Season—Period of time the court is to be in operation during the year is the foundation upon which all financial plans are laid.

Distance Off Highway—The motor court is "selling" *sleep*, thus a reasonable set-back from the highway which still presents a good view is most desirable.

Gradient of Highway—Do not locate at a point where trucks must shift gears in order to get over a hill.

Signs—Site selected must be adaptable to the placing of several good signs to attract attention and give directions to the court.

Natural Stops—Such spots are those where the motorist naturally slows down such as intersections, top of hills, edge of towns or where a highway is close to lake shores or rivers.

Surroundings—The type of land use near the motor court should be harmonious with the quiet atmosphere and attractiveness of the modern court.

Nearness to Town—Motorists want to be conveniently near com-

munity facilities and the best way to provide them with these services is to be located not more than 8 miles or a 15-minute drive from the shopping district of the nearest town.

Competition—A survey should be made to determine the present number of transient rooms in a community, the amount of demand for these rooms, and the profit possibilities of establishing a new court before going ahead with construction.

Nearness to Food Service, Grocery, Car Service—If these services are not readily at hand, arrangements for providing them is advisable.

Public Utilities—Electricity from high lines and abundant good quality water supplies are essential to efficient operation.

Place of Origin of Patronage—The motor court should be located where the largest possible percentage of passing motorists are looking for a place to spend the night. In the study made of 12 representative, successfully operated motor courts, it was found that there is a very definite relationship between the particular location chosen and the place of origin of its patronage. If the motor court is to have a profitable location, it must be so situated that it will provide a convenient stop for motorists coming from the large population centers of southern Michigan as well as from the heavily populated sections of states nearby Michigan.

Length of Stay—The major portion (87.1 percent) of patronage of the 12 motor courts studied stayed only one night.

Composition of Parties—More than half (59.1 percent) of parties are couples; 20.3 percent are single travelers; larger parties of three, four and over four persons make up 20.6 percent of the trade. Motor court rooms should be adapted to accommodate different sized groups.

Length of Day's Drive—The American Automobile Association national average shows about 320 miles a day to be the prevailing daily driving distance. On an hourly basis, the average miles per hour is at the rate of 100 miles for every 3 hours of driving time.

Time of Departure of Tourists—A total of 52.8 percent of all motorists interviewed departed originally from their homes between 6:00 a.m. and 12:00 noon, 27.4 percent departed between 12:00 noon and 6:00 p.m. Thus, the majority of travelers departed from home on their trips in the morning hours after 6:00 a.m.

Size of Tract Needed—Sufficient land should be purchased at the outset to accommodate the size of court ultimately to be built.

Cost of the Tract—Cost of the tract should be about one-sixth of

the cost of the entire development. It is usually wiser to pay a little more for a first-class location than to try to save money on land and accept an inferior location.

Shade Trees—Experienced operators recommend a gently sloping rise of ground with a few good native trees. Some sunshine and some shade is better than too much of either.

Zoning and Building Code—Zoning and building ordinances may be enacted by cities, villages, townships, and counties. As construction of motor courts is sometimes prohibited or limited by such ordinances, information should be obtained from the respective clerks of the unit of government in which the court is to be located.

Points of Interest Nearby—It is usually advantageous to be located near points of interest which tend to attract visitors into the region.

Police and Fire Protection—Nearby post of the State Police is helpful in maintaining an orderly motor court. Investigate services of city and township fire departments.

Area Promotion—A strong chamber of commerce and regional tourist promotion organization can help generate business for the motor court.

Customer Preferences in Location—The likes and dislikes of the customers are of considerable consequence when choosing a location. From the August and September 1948, survey of 197 touring groups at the Straits of Mackinac it was found that 71.1 percent preferred overnight cabins for their accommodation. Hotels were the choice of 10.2 percent and 9.1 percent preferred tourist homes when traveling. Only 3 percent preferred trailer coach parks followed by 2.5 percent liking camping best. Most of the people interviewed said they preferred cabins because they were more private and more convenient. On the other hand, most of those preferring hotels remarked that they thought a hotel was more convenient. When asked where they liked overnight accommodiations located, 55.8 percent stated, "At the edge of a town." "Near a lake" was preferred by 16.3 percent and "in the country" was the choice of 14.7 percent.

Many interesting comments regarding Michigan's tourist business were obtained from the motorists interviewed. Some of these were: "We like the state parks," "roadside parks excellent for the common man," "highways excellent," "too much beer," "rest rooms in gas stations and state parks poor," "need simple meals well cooked," "tourist accommodations are wonderful," "need better ferry service," "Michigan accommodates all kinds of people."

MOTOR COURT LOCATION EVALUATION SHEET

Practical results of the investigations made have been grouped in a convenient table. Anyone considering the development of a site for motor court use or purchasing an existing establishment can use this evaluation sheet to determine its rating. Analysis of the criteria ratings made can result in a much more intelligent choice of location than if no such guide was used.

Instructions: For each of the points listed, make a check mark in the rating column showing how it reflects your appraisal of the answer in the first column.

Criteria	Answer	Rating			
	Check yes or no, numerical or qualitative answer	Excellent	Good	Fair	Poor
Physical aspects:					
Soil type					
Topography					
Surface drainage					
Internal drainage					
Septic tank drain					
Landscaping					
Growing lawn					
Economic aspects:					
Accessibility					
View					
Permanence					
Traffic count:					
out-of-state					
Michigan					
Local					
Length of season					
Distance off highway					

Criteria	Answer	Rating			
	Check yes or no, numerical or qualitative answer	Excellent	Good	Fair	Poor
Gradient of highway					
Signs					
Natural stop:					
intersection					
curve					
good view					
lake or river					
hill top					
Surroundings:					
Quiet					
Harmonious					
Nearness to town					
Competition:					
No. of courts					
No. of hotels					
No. tourist homes					
Number of services:					
Food service					
Grocery					
Gas station					
Public utilities:					
Electricity					
Water					

Criteria	Answer	Rating			
	Check yes or no, numerical or qualitative answer	Excellent	Good	Fair	Poor
Gas					
Telephone					
Origin of patronage:					
Nearest large cities					
Distance					
Length of day's drive:					
Distance from large cities					
Size of tract					
Cost of tract					
Shade trees					
Zoning					
Building code					
Points of interest					
Police and fire protection					
Area promotion					

THE AVAILABILITY TO THE RAT OF CERTAIN CAROTENES IN RAW AND COOKED VEGETABLES[1]

By MARION A. WHARTON[2] and MARGARET A. OHLSON
SECTION OF FOODS AND NUTRITION

THE LITERATURE presents many discrepancies concerning the utilization of carotene as vitamin A by experimental animals (Guggenheim, '44, Fraps and Meinke, '45a, Kemmerer and Fraps, '45a, Treichler *et al.*, '42, Kemmerer and Fraps, '43, Deuel *et al.*, '45a, Kemmerer and Fraps, '45b, Deuel *et al.*, '44, Deuel *et al.*, '45b). Human foods have not been studied extensively as to the relative proportions of biologically active carotenes which they contain, and very little has been published on the carotene content of food after cooking. Therefore a study was undertaken of the concentration of alpha- and beta-carotene in cooked spinach and carrots and the biological availability as shown by growth response, fecal excretion and liver storage in the growing rat.

EXPERIMENTAL PROCEDURES

PROCESSING AND SAMPLING OF VEGETABLES

Spinach, purchased on the local market in November 1945, was washed, the midribs removed, cut into small pieces and mixed. Five-hundred-gram samples were cooked for 10 minutes in 2.5 times their weights of boiling water. Carrots purchased on the local market at the same time were washed and cut in half longitudinally. Each half carrot was grated crosswise and one-half was cooked for 9 minutes in 2.5 times its weight of boiling water.

The raw and cooked samples were analyzed spectrographically, packaged in 10-gram lots, sealed in cellophane bags, quick frozen at –40° F. and stored at –10° F. Analyses were repeated after 3 months' storage.

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[1]The data for this paper were taken from a thesis submitted by the senior author in partial fulfillment of the requirements of the Ph.D. in Nutrition, June 1947. The complete thesis is deposited with the Michigan State College Library as Microfilm No. 888. Abstract published in *Microfilm Abstracts*, 7: 28 (1947).

[2]Present address: Ohio State University, Columbus.

ARTICLE 32-16

BIOLOGICAL METHODS

Rats, 22 to 23 days of age, from a colony maintained on a low vitamin A and vitamin D ration, were housed individually in screen-bottomed cages and fed U.S.P. XII vitamin A-free ration *ad libitum*. Each experimental group consisted of five male and five female animals. Feces from each animal fed carotene or vegetables were collected daily into individual stoppered bottles, stored under ethanol and refrigerated. Supplements of vitamin A or carotene as given in Table 2 were fed twice weekly in series 1 and 4 times weekly in series 2. A depletion period was omitted since, in the preceding year, it was demonstrated that weanling rats from this colony responded more uniformly to vitamin A than did depleted rats. The animals were sacrificed on the morning of the 29th day, and the livers removed and frozen for vitamin A analysis. Gross examinations for evidences of infection were made.

Vitamin A alcohol (Distillation Products, Inc.) and alpha- and beta-carotenes (General Biochemicals, Inc.) were fed in vegetable oil[3]. Mixed tocopherols[4] were dissolved in oil and fed in the required concentrations to the negative controls and vegetable groups. All groups in series 1 received 0.5 mg. of the mixed tocopherols and in series 2, 1.0 mg. daily.

The vegetables were prepared daily for rat feeding by weighing 10 grams of frozen material and mixing in a micro Waring blender with a heavy hydrolyzed starch solution. The suspension was made to volume and fed orally from one milliliter hypodermic syringes.

The growth data were corrected for the effect of initial weight and food consumption by analyses of covariance. The significance of gains between groups was determined by "t" values.

CHEMICAL METHOD

The carotene content of the vegetables was determined by Beadle and Zscheile's method (1942) except that cyclohexane was used for the spectrographic reading. This necessitated the use of ethanol and petroleum ether for the biphasic extraction of the vegetable tissue. The standard absorption curves and coefficients were determined on alpha- and beta-carotene (General Biochemicals, Inc.) in cyclohexane purified for spectrographic determinations (Eastman, Inc.).[5]

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[3]Wesson.

[4]Vego, a concentrate in oil obtained from Distillation Products, Inc.

[5]A Beckman quartz photoelectric spectrophotometer was used.

Absorption values were determined at wave lengths 4340, 4530, 4700 and 4820 A°, co-incident points of the curves for alpha- and beta-carotene in cyclohexane solutions. Specific absorption coefficients at these wave lengths for cyclohexane solutions were found to be 159, 215, 175, and 186 liters per gram centimeter, respectively. Wave lengths 4820 and 4900 A° were used for analyses of extracts as two-component systems for alpha- and beta-carotene according to the method of Beadle and Zscheile ('42).

Both the feces and livers were extracted with ethanol and refluxed for 30 minutes with potassium hydroxide in low actinic glassware. The solutions were extracted with petroleum ether, washed with 85-percent ethanol, dried with anhydrous sodium sulfate, and evaporated to dryness under reduced pressure. The residues were dissolved in cyclohexane, diluted to 25 ml. Wave length of 4530 A° was used for measuring total carotenes and 3260 A° for vitamin A.

The extract from feces contained a material which absorbed light through the wave lengths 3000 to 5000 A°. This absorption varied with the weight of the feces. In group 1 the average E 4530 value on a 25-ml. extract per gram of feces was 0.0131 for male negative control rats and 0.0151 for females; in group 2, 0.0164 for the male controls and 0.0170 for female controls. These values were used to correct all carotene determinations reported for feces.

TABLE 1—*Carotene content of raw and cooked vegetables, fresh and after frozen storage*

Vegetable	Frozen storage	Total carotene content				Carotene loss 4530A°	Beta-carotene 4820-4900A°
		4340A°	4530A°	4700A°	4820A°		
	months	mg. per 100 g. fresh weight				percent	percent
Raw spinach	0	6.18	5.96	6.00	5.89		81.6
	3	5.90	5.56	5.51	5.37	6.7	88.6
Cooked spinach	0	7.23	6.92	7.30	7.25		94.1
	3	6.87	6.70	6.71	6.59	3.2	95.0
Raw carrot	0	11.00	10.53	10.93	11.04		76.4
	3	11.04	10.61	10.63	10.63	+0.8	69.1
Cooked carrot	0	10.44	9.64	9.59	9.37		62.3
	3	11.60	10.75	10.84	10.63	+11.5	64.9

All figures represent triplicate analyses.
All analyses are expressed on the fresh-weight basis.
The total carotene fraction was analyzed spectrographically as a mixture of alpha-and beta-carotenes.

RESULTS AND DISCUSSION

The carotene contents of the raw and cooked spinach and carrots during frozen storage are reported in Table 1. Storage caused no significant change during the 3-month period while the vegetable was being used for the biological assay.

The total carotene concentrations in Table 1 do not check as determined at the various coincident points, (Harper and Zscheile '45, and Kemmerer, '46). In every case, the results calculated at 4340 A° are higher than at the wave lengths 4530, 4700 or 4820 A°, probably because the carotene extracts contained not only alpha- and beta-carotene but also pigments which Harper and Zscheile ('45) identified as zeta-carotene in carrot extracts.

The relationship of gain in weight to the daily supplements of beta-carotene is presented in Fig. 1 for male and female rats, fed 0.45, 0.70, 1.03, 1.36 and 2.00 micrograms per rat per day. The group receiving 7.0 micrograms per rat per day was not included since the growth response from this greater amount of carotene was not linear

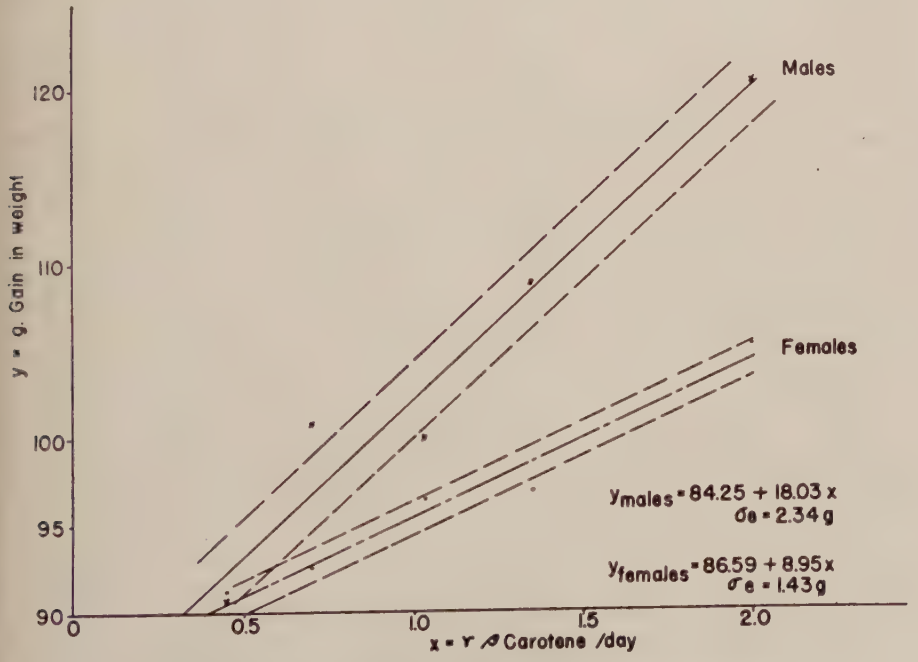

Fig. 1. Relationship of gain in weight to dosage of beta-carotene for male and female rats.

TABLE 2—*Growth and food intake of rats fed various carotenes and vitamin A alcohol for 28-day period*

Supplement	Daily intake	Males					Females				
		Initial weight	Food intake	Gain in weight	Adjusted gain*	Beta-carotene equiv.**	Initial weight	Food intake	Gain in weight	Adjusted gain*	Beta-carotene equiv.**
	γ	g.	g.	g.	g.	γ/day	g.	g.	g.	g.	γ/day
Series 1											
0	0	48.6	254	59.0	75.0	.....	42.8	240	57.4	77.7	.....
Beta-carotene	0.45	48.4	269	80.8	90.7	.....	48.4	289	89.4	91.2	.....
Beta-carotene	0.70	48.0	288	98.4	100.9	.....	47.0	293	92.8	92.6	.....
Beta-carotene	1.03	51.2	331	114.6	100.0	.....	46.6	297	98.4	96.5	.....
Beta-carotene	1.36	48.2	323	121.2	109.1	.....	47.2	310	104.0	96.9	.....
Beta-carotene	2.00	46.4	300	123.8	120.6	.....	46.4	265	94.4	105.4	.....
Vitamin A Alcohol	0.46	51.2	299	104.4	102.8	1.03	49.4	281	87.0	92.2	0.64
Alpha-carotene	2.36	47.6	307	111.0	105.3	1.16	50.4	302	93.0	90.0	0.40
Raw spinach	3.82†	50.8	347	138.6	117.4	1.84	47.2	311	104.4	96.9	1.16
Cooked spinach	3.82†	50.2	331	129.8	114.9	1.70	46.8	295	97.0	95.9	1.05
Raw carrot	3.82†	47.8	324	118.6	106.0	1.20	49.8	298	93.4	91.8	0.59
Cooked carrot	3.82†	47.4	331	126.6	111.1	1.49	50.2	294	96.6	96.8	1.16
Series 2											
0	0	42.8	209	57.6	90.5	.....	41.4	222	69.2	96.5	.....
Beta-carotene	7.0	42.8	315	138.6	128.4	.....	41.6	278	113.2	117.8	.....
Alpha-carotene	23.6	48.0	329	147.0	132.4	.....	42.2	253	103.6	118.5	.....
Vitamin A Alcohol	4.6	45.6	298	121.4	118.8	1.92	45.0	273	92.4	99.8	1.49
Raw carrot	20.0†	44.4	296	130.0	127.9	.....	43.4	285	113.0	115.2	.....
Cooked carrot	20.0†	43.8	304	132.6	122.1	.....	42.8	284	111.6	114.0	.....

Each figure represents the average of data of five animals.
*Gains adjusted by covariance to correct for variation in initial weight and food consumption.
**Beta-carotene equivalent was determined from the beta-carotene gain—dosage curve, (Figure 1).
†Total carotene as determined spectrographically.

in relation to the lower dosages. The regression coefficient b, for the regression equation y = a + bx, was obtained from the formula

$$b = \frac{\Sigma xy - \frac{(\Sigma x)(\Sigma y)}{n}}{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}$$

and a from the formula a = My − b Mx where y equals increase in weight (grams) of rats in 4 weeks and x equals the daily dose of beta-carotene in micrograms. The error of estimate was 2.34 g. for the males and 1.43 g. for the females. In the males, gains for three of the five groups were within one error of estimate from the regression line; in the females, four of the five were within one error of estimate. These regression lines were used for interpretating the results of feeding the vegetable supplements.

When the relationship of gain in weight to the daily supplement of beta-carotenes was calculated by the method of Coward ('38), using the logarithm of the daily dose, practically identical results were obtained.

Table 2 presents the gain in weight, food consumption, and the gain in weight adjusted by covariance for initial weight and food intake for the rats in series 1 and 2. Both sex and treatment resulted in highly significant growth differences.

In series 1 all animals receiving carotene or vitamin A made significantly greater gains than the negative animals, but there were no significant differences among groups receiving 0.45, 0.70 or 1.03 micrograms beta-carotene daily. There were, however, significant differences in the gains of rats receiving 0.45, 1.36 and 2.00 micrograms of beta-carotene daily. These differences became progressively greater with greater differences in carotene intake. There was no significant difference in growth between groups of rats fed raw spinach, cooked spinach or cooked carrot. However, those fed raw carrot gained significantly less than those on raw spinach ($p < .05$).

When supplements were calculated as micrograms of beta-carotene on the basis of growth-promoting abilities, the ratios[6] of beta-carotene to vitamin A alcohol, alpha-carotene, the total carotenes of raw spinach, cooked spinach, raw carrot and cooked carrot for male rats were 1.00: 0.45: 2.03: 2.08: 2.25: 3.18: 2.56, respectively, and for female rats 1.00: 0.72: 5.90: 3.29: 3.64: 6.47: 3.29 micrograms of beta-carotene respectively. The literature supplies little information regarding

[6]Formula used was: $\frac{\text{daily intake of supplement in micrograms}}{\text{beta-carotene equivalent in micrograms per day (Table 2)}}$

the requirement of vitamin A of the female rat for growth. On each intake of carotene and vitamin A the response of the females was poorer than that of the males.

The estimated vitamin equivalent of beta-carotene to vitamin A alcohol of 1.00: 0.45 for male rats compares well to that of Harris and co-workers ('44) and Hickman *et al.* ('44). The alpha-carotene ratio for male rats of 1.00: 2.03 substantiates data presented by Deuel *et al.* ('45a). The females, however, utilized the alpha-carotene only half as well as the males for growth. The beta-carotene equivalent of all vegetables was lower than that reported by Oser and Melnick ('45).

Raw carrots had a lower beta-carotene content, and their bioassay value was lower than the raw spinach. Cooked carrots had a higher

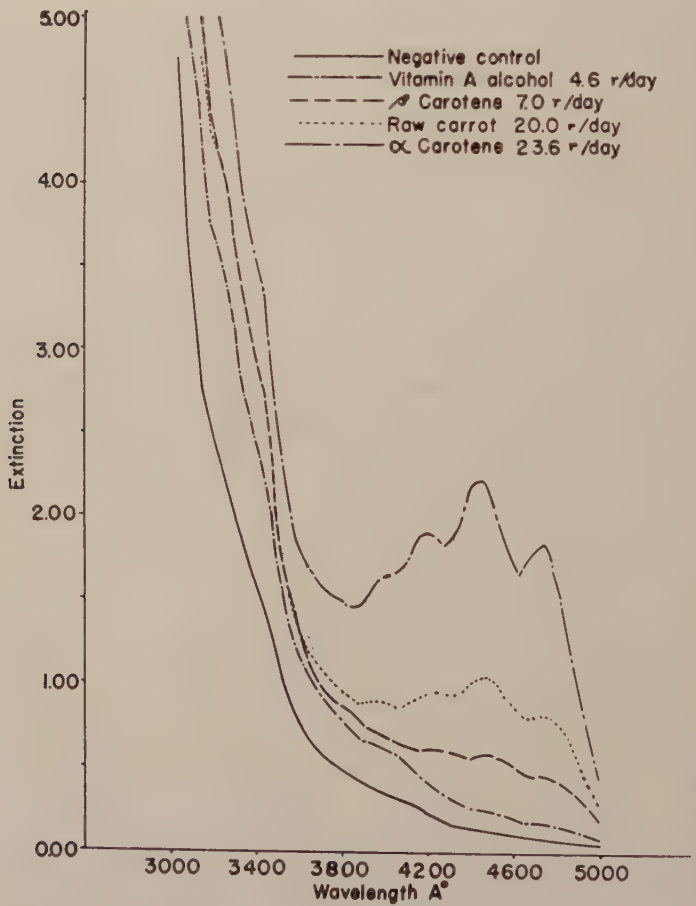

Fig. 2. Absorption spectra of carotene extract of rat feces.

biological value, but not significantly so, than the raw, although their beta-carotene content was lower. In this work the physical effect of the cooking of the vegetables on their digestibility was removed as all vegetables were ground to a fine suspension in a Waring blendor.

The negative group of rats fed 1.0 mg. daily of mixed tocopherols made significantly greater gains than those fed 0.5 microgram (series 1), when the gains were corrected for initial weight and food intake. However, the food intake of the negative group in series 1 was greater than in series 2, in fact, so much so that both groups were receiving essentially the same amount of vitamin E; thus the difference shown by the adjusted weights may not be attributed to tocopherol intake (Hickman *et al.* '44).

Figure 2 presents the average absorption spectra of two or more carotene extracts of male rat's feces collected during the 4-week experimental period for the negative group, the groups fed with vitamin A alcohol 4.6 micrograms daily, beta-carotene 7.0 micrograms, alpha-carotene 23.6 micrograms and raw carrot 20.0 micrograms of total carotenes per day. The corresponding female groups presented similar absorption curves. It is noted that feces from the negative group and the animals receiving vitamin A alcohol both absorbed light throughout the 4000 to 5000 A° area.

The absorption may be due to some material in the ration (Russell *et al.*, '42, Kemmerer and Fraps, '38, and Wilson and co-workers, '46) or excretory product, possibly resulting from the earlier sexual development of the treated rats. Feces extracts of the vitamin A alcohol group absorbed more light than those from the negative group. The food consumption of the former group was greater as was also the growth response and the weight of the feces. All groups fed carotene showed absorption maxima characteristics of carotenoids superimposed upon this broad band. Therefore, direct spectrographic readings for total carotenes of feces should present true values if corrected by a blank prepared from the negative control group and based on the weight of feces rather than a total correction per rat. Feces extracts from the vitamin A alcohol groups showed no maxima at 3260 A° and, in this region all groups, including the negative controls, absorbed a high percentage of the light. Therefore no quantitative values for vitamin A excretion could be obtained in this research.

Table 3 presents the excretion data. There was wide variation in the amount of carotene excreted by individual rats and this was more marked at the low feeding levels than when the animals were receiving

TABLE 3—*The fecal excretion and absorption of carotenes by rats*

Material fed	Carotene intake	Males			Females		
		Excretion		Absorption†	Excretion		Absorption
	Total in 28 days	Total in 28 days	Range		Total in 28 days	Range	
	γ	γ	γ	percent	γ	γ	percent
Beta-carotene.....	12.6*	3.5	0–9	72	1.6	0–3	88
Beta-carotene.....	19.6	6.7	0–13	66	2.7	0–8	86
Beta-carotene.....	28.8	11.2	2–16	61	2.6	0–5	91
Beta-carotene.....	38.1	5.2	2–10	86	6.0	0–10	84
Beta-carotene.....	56.0	22.1	8–36	61	17.3	12–26	69
Beta-carotene.....	196.0	38.3	35–42	81	50.6	41–64	74
Alpha-carotene....	66.1	8.4	4–13	87	8.7	0–19	87
Alpha-carotene....	660.8	152.0	61–207	77	127.9	89–164	81
Raw spinach**....	107.0	16.5	13–22	85	16.2	3–26	85
Cooked spinach....	107.0	24.2	17–34	77	23.6	0–57	78
Raw carrot.....	107.0	10.9	4–16	90	18.2	13–21	83
Cooked carrot.....	107.0	18.2	1–30	83	17.9	6–26	83
Raw carrot.....	560.0	105.9	86–141	81	124.7	89–153	78
Cooked carrot.....	560.0	116.9	93–148	79	139.8	108–188	75

*Each figure represents the average of data from five animals.

**Vegetables were fed as total carotenes determined by spectrographic analyses.

†The term absorption is used to measure the difference between the amounts of carotene fed and the amounts excreted.

adequate amounts. The percentage carotene absorbed on intakes of 0.45, 0.70 and 1.03 micrograms daily was higher for the female group than for the male but at all higher feeding levels there was no consistent variation between the utilization for male and female groups. In all groups in series 1 there were nine female and two male rats which did not excrete carotene.

There was no marked difference between the percentage of beta-carotene, alpha-carotene, raw and cooked spinach and carrot absorbed and, in all cases, the percentage was better than that reported by Fraps and Meinke ('45a and b). The absorption of carotene from the raw vegetables tended to be better than the cooked and the carotenes from spinach were absorbed as well as those from carrot.

Figure 3 presents the absorption spectra from wave lengths of 3000 to 3500 A° of a vitamin A extract of a rat liver from each of the following groups: negative, beta-carotene 7.00 micrograms per day, alpha-carotene 23.6 micrograms, cooked carrot 20.0 micrograms and vitamin A alcohol 4.6 micrograms per day. All groups presented approximately equal absorption which decreases as the wave length increases and shows no absorption maximum at 3260 A°; thus the presence of vitamin A was questionable. One-half of the extract of liver from 10 of these animals was tested by the Carr-Price method and no blue color

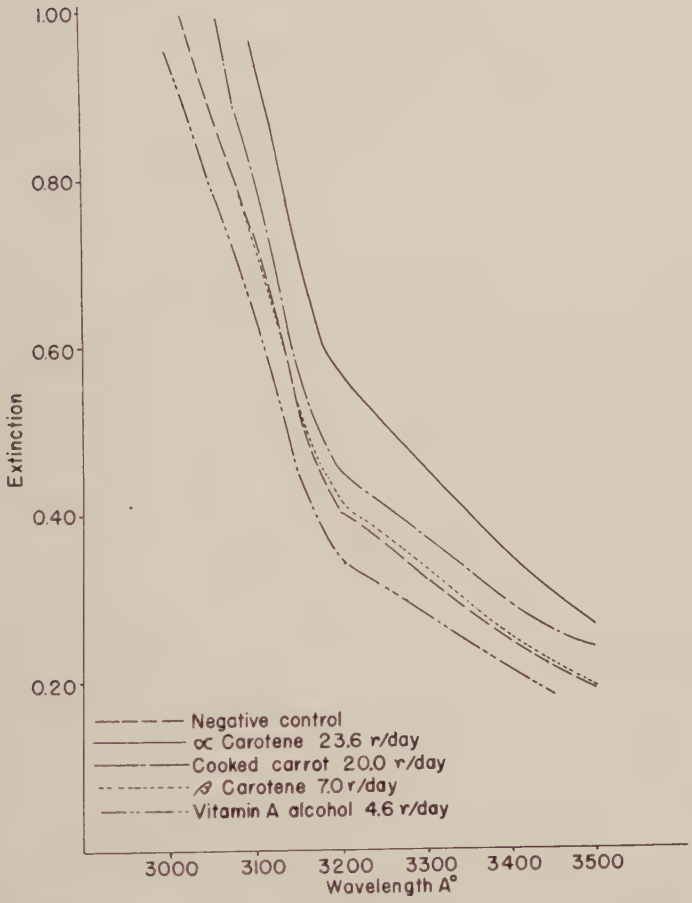

Fig. 3. Absorption spectra of cyclohexane extract of rat livers.

was formed. The sensitivity of the absorption method was tested further by weighing two portion of 4 grams each from a liver and adding vitamin A alcohol to one before carrying out the analytical procedure described. The percentage recovery ranged from 98 to 107 when 7 to 36 micrograms of vitamin A alcohol were added.

The absorption, at wave length 3260 A°, was in agreement with the work of Treichler, Kemmerer and Fraps ('42) for what they termed pseudo vitamin A. The absorption spectra of these livers were studied from 2200 to 5000 A° wave length and the density decreased as the wave length increased except for an absorption maximum between 2500 to 2600 A°. With the carotene groups the extracts were pooled and reduced to a small volume for the reading of the absorption spectra

from 4000 to 5000 A°. The absorption decreased as the wave length increased with no indications of maxima which might be considered characteristic of carotene. Therefore, no carotene was stored in the liver when 20.0 micrograms per day were fed for a 4-week period.

SUMMARY AND CONCLUSION

Spinach and carrots, purchased in the local market were analyzed spectrographically for total carotenes and alpha- and beta-carotene in the raw and cooked state and after 3 months of frozen storage. Weanling rats on a vitamin A-free ration were fed beta-carotene, alpha-carotene, vitamin A alcohol and raw and cooked spinach and carrots at several intakes for a 28-day period. The growth response, fecal excretion, absorption and liver storage of vitamin A were studied.

The total carotene content of raw spinach was 5.96 mg. per 100 g. of vegetable, and on carrots 10.53 mg. The percentage beta-carotene was 81.6 for raw spinach and 76.4 for raw carrot. Cooked spinach contained 6.92 mg. total carotene and cooked carrot 9.64 mg. per 100 g. of vegetable with 94.1 percent beta-carotene in cooked spinach and 62.3 percent in cooked carrot. Frozen storage resulted in little change in the carotene content in three months. Cooking produced some changes in the absorption curves.

In the growth study of weanling rats, all sources of vitamin A were calculated to micrograms of beta-carotene from the beta-carotene growth response curve. The ratio of beta-carotene to vitamin A alcohol, alpha-carotene, the total carotenes of raw spinach, cooked spinach, raw carrot and cooked carrot for male rats are 1.00: 0.45: 2.03: 2.08: 2.25: 3.18: 2.56 of beta-carotene respectively, and for female rats 1.00: 0.72: 5.90: 3.29: 3.64: 6.47: 3.29 micrograms of beta-carotene respectively.

The percentage carotene absorbed by groups of five animals ranged from 61 to 91 but there was little difference between the various supplements fed. At low feeding levels there was great variation in utilization within groups and females in these groups absorbed carotene more completely than males. The absorption spectra of negative control rats feces decreased in density with increasing wave length from 3000 to 5000 A°. When carotenes were fed, there was superimposed upon this, absorption maxima, characteristic of carotenoids. The absorption not due to carotenoids necessitated the use of a suitable blank obtained, in this case, from the negative control group.

Rats stored no vitamin A in the liver at any amount fed. Absorption spectra of extracts of rat livers from wave lengths of 2200 to 5000 A° decreased in density with increasing wave length except for a maximum between 2500 and 2600 A°. This absorption would necessitate the use of suitable blanks for the spectrographic determination of vitamin A in rat livers.

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OCCURRENCE OF FIRE BLIGHT IN BARTLETT PEARS AS INFLUENCED BY CERTAIN CULTURAL PRACTICES

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SECTION OF HORTICULTURE

AMONG THE MANY diseases that attack fruit trees, fire blight is one of the most destructive. Its wide distribution throughout the principal fruit-growing areas in North America makes it of considerable economic importance. The pear is particularly subject to its destructiveness. During seasons favorable for its development and spread, the younger pear orchards often become so badly infected with the blight organism that many trees are completely destroyed within the course of one year.

In some areas in the United States pear growing has been greatly restricted because of fire blight. In Michigan, although rather serious outbreaks of this disease have occurred periodically, it is not so destructive generally as to limit pear production greatly where good orchard management practices are employed. Nevertheless, the damage caused by fire blight is one of the major problems confronting the pear industry in the state.

Until recent years Michigan pear growers have almost exclusively followed the clean culture-cover crop system of soil management in their orchards, disregarding more or less the type or fertility of the soil upon which the orchards are set. This method of soil management in most cases proved desirable, particularly for those orchards planted on the lighter and less fertile types of soil, where the amount of tree growth is generally less and more easily controlled by the use of fertilizers. However, where such cultural practices are employed in pear orchards growing on the heavier, deeper and more fertile soils, pear growers very frequently have had serious difficulty in keeping fire blight under control. During favorable growing seasons on naturally fertile loamy soils the growth of the trees is luxuriant and often excessive, particularly in the case of the younger or non-bearing

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trees. Experiences have shown that such vigorous or succulent growth is more susceptible to the fire blight infection than the less succulent type of growth, and that it is more often attacked by the disease. Once infection occurs in vigorously growing wood, the organism usually destroys the affected twigs and branches with great rapidity, and very often the whole tree.

The probability of avoiding overgrowth in twigs by means of some modified soil cultural practice, one particularly adapted for use in the heavier and more fertile soils, would seem to be entirely possible. Therefore, in order to develop, if possible, a practical method of handling pear orchards on fertile loamy soils, and to determine the influence such a modified soil cultural practice might have upon the susceptibility of the trees to fire blight infection, a planting of pears was made in 1920 at the Graham Experiment Station near Grand Rapids. Bartlett, the most commonly grown variety in Michigan and one of the least resistant to fire blight infection, was selected for this experiment. The trees were set 20 feet apart on a fertile clay loam soil underlain by a clay subsoil having a high water-holding capacity. The planting was divided into two plots. The experiment covered the period from 1920 to 1944 inclusive.

PROCEDURE

During the first 4 years both plots were kept under the clean culture-cover crop system of soil management. Following the usual spring and summer cultivation one plot was seeded to alfalfa during the late summer of 1924. The remaining plot was continued under the clean culture-cover crop system for the duration of the experiment. Cover crops used were oats, buckwheat or a mixture of these two, seeded during the first half of August. The alfalfa in the sod plot was mowed twice annually, raked up and placed under the trees as a mulch. Within 5 years after seeding, the alfalfa had practically all died out, having been replaced largely by bluegrass. The grass was mowed once during the early summer and spread under the trees. During the last 8 years of the experiment the grass was mowed but left lying in the swath. In the fall of 1933 about one-third yard of strawy manure was spread under each tree in the sod plot. Each of these trees was again mulched in the summer of 1944 with approximately 50 pounds of a mixed grass hay.

In addition to the cultural treatments outlined, all trees in both plots were given annual spring applications of 2 pounds of ammonium

sulfate fertilizer starting in 1924. These fertilizer applications were increased to 3 pounds per tree in 1928, 4 pounds in 1937 and to 5 pounds in 1943. The pruning and spraying practices were the same for all trees.

RESULTS

Only slight differences in growth between the trees in sod and those under clean culture were evident the first year after the alfalfa sod had become established. These growth differences gradually became more apparent until at the end of the fifth year, following seeding of the alfalfa, the average trunk circumference increase for the trees in the clean culture-cover crop plot was nearly 2 inches greater than for the trees in the sod-mulch plot. The demand of the sod for moisture and nutrients offered sufficient competition to retard somewhat the trunk and twig growth of the trees in the latter plot. However, this gradual reduction in growth was not as yet sufficient to influence materially the susceptibility of the twig growth to blight infection by 1927, the third year after the alfalfa sod had become established. During this year one tree in the sod-mulch plot was quite seriously infected with twig blight, requiring the removal of several large branches the following winter. In 1928 one additional tree in the sod-mulch plot was so badly infected during the summer that it had to be removed. Up to this time no fire blight infection had occurred in the clean culture-cover crop plot, although the tree growth here was more vigorous.

Conditions for both tree growth and fire blight infection were very favorable in 1929, and the disease went rampant. Fourteen of the twenty-four trees in the clean culture-cover crop plot were so seriously infected in the twigs, main branches and the trunks that their removal from the plot was necesary in the spring of 1930. Only three trees, similarly damaged, were found among the 48 trees in the sod-mulch plot in 1929. These likewise had to be removed from the planting. Of the remaining trees in both plots, few escaped some degree of infection during 1929. The scattering blight-infected twigs and branches in these trees were readily removed, however, without affecting to any extent the future usefulness and productivity of the trees.

Prior to the spring of 1930 no attempt was made to control twig blight during the active growing season of the trees. Once infection occurred the disease was permited to run its course, resulting in the total destruction of 18 of the 19 trees seriously attacked up to that time.

Only the irreparably blighted trees and branches were removed during the following winter or spring, as were likewise any remaining hold-over blight cankers that could be found. It became apparent, however, that the increasing intensity of fire blight infections in this eleven-year-old pear orchard would make it necessary to adopt additional control measures if the remaining trees were to be saved for future blight studies. Consequently, starting in the spring of 1930 all trees were examined from one to three times weekly, depending upon the rapidity of the twig growth and the amount of twig blight in evidence. These periodic inspections were continued during the season until no further blight infection appeared. At each inspection all blighted tips and branches, as they appeared, were removed by breaking out the diseased wood at a point 12 to 18 inches below the lowest point of visible infection.

Although all the diseased wood previously found had been taken out in this block of pear trees, twig infections continued to appear in large numbers during 1930. It was only through persistent efforts that the disease was held in check and further losses of trees averted. Following this season the severity of twig infections gradually decreased, fluctuating somewhat in intensity from one year to the next. This decline was more pronounced after the trees came into full bearing which reduced considerably all phases of tree growth. Covering the period from 1930 to 1939 inclusive, a greater total number of blighted twigs and branches were removed per tree in the clean culture-cover crop plot than from the sod-mulch plot. However, during the last five years of this experiment only a few blighted twigs were found annually and these were rather uniformly scattered throughout the trees in both plots. They occurred almost exclusively in the extreme tops of the trees where the growth was most vigorous.

In addition to the trees lost because of twig blight infection, five trees had to be removed from the planting, during the period from 1932 to 1944 inclusive, because of serious blossom infection by the blight organism. After the blossoms became infected the disease worked its way through the spurs directly into the main branches then into the trunk, girdling it completely in most cases. This type of infection was not directly associated with tree vigor or the cultural practices used in this experiment.

GENERAL DISCUSSION

In view of the various factors that influence the probability and severity of fire blight infections, no single control practice is effective in preventing blighting of the twigs, branches, and blossoms. The elimination of all hold-over blighted tissue in nearby trees and plantings during the winter and early spring is the most effective single control measure that the grower can employ. It is from these primary infection sources that the blight organism is transferred in the spring to the tender twigs and blossoms. Likewise, the prompt removal of all blighted twigs and branches as they appear in the trees during the growing season, prevents the blight organism from traveling downward into the larger branches, trunk, and roots where they may prove fatal to the trees. Also, this practice eliminates the formation of many hold-over cankers which would be an added source of blight infection the following season.

The amount of annual terminal shoot growth that either the young, non-bearing or the older bearing pear trees should be permitted to make safely, can not be stated definitely. Much will depend upon the presence of active fire blight in other nearby trees. In the absence of active fire blight in adjacent pear and apple trees, it has been observed that young non-bearing pear trees, making an annual growth of 2 or more feet, have remained free from blight infection. In contrast, annual twig growth not exceeding 6 inches in length were frequently found to be moderately infected with blight on bearing pear trees when growing adjacent to or near other blight infected pear or apple trees. These observations would suggest that pear trees could be permitted to make a longer annual shoot growth when grown in or near other blight-free orchards. However, should blight start to infect such young pear trees then their growth should be immediately checked by reducing or withholding fertilizer applications, and by seeding the orchard area to a sod cover.

Aside from this, the age at which the pear orchard should be seeded to sod will depend largely upon the fertility and water-holding capacity of the soil, and the degree of surface slope. In this particular experiment no blight infection appeared until the trees were in their eighth year in the sod-mulch plot, and in the tenth year in the clean cultivated-cover crop plot. However, since all trees were well established prior to this time, a sod cover could have been seeded at an earlier date without seriously affecting tree performance. The tree

growth could readily have been regulated through fertilizer application. In addition to aiding in the control of fire blight in the pear orchard by reducing the succulence of the twig growth, the sod cover practically eliminates the loss of the fertile surface soil by wind and water erosion, particularly on sloping land. Likewise, it increases the porosity of the soil and tends to maintain the soil organic matter at a higher level. Such advantages are very important to the present and future success of fruit growing, and should not be overlooked.

CONCLUSIONS

From the foregoing discussion and data presented it can be definitely concluded that under the conditions of this experiment the sod-mulch system of soil culture was reasonably effective in helping to keep twig blight of Bartlett pear trees under control. This is evident from the fact that a larger number of trees had to be removed, because of more fatal blight infection, from the clean culture-cover crop plot than from the sod-mulch plot. Also, that during the period of 1930 to 1939 inclusive, more twigs and branches infected with blight were found in this same plot than in the sod-mulch plot. The results also indicate that blight infections were more likely fatal to the trees during their vigorously growing, non-bearing years than similar infections during their later years. As the trees came into bearing their growth simultaneously became less vigorous and succulent, and more resistant to the invasion and rapid movement of the blight organism. This decrease in the growth and succulence of the twigs was further hastened by the competition of the sod cover for moisture and nutrients in the sod-mulch plot, thereby encouraging the type of growth resistant to blight infection, and at an earlier date.

WHAT BECOMES OF THE CALVES IN PUREBRED DAIRY HERDS?

By RUSSELL E. HORWOOD and EARL WEAVER
SECTION OF DAIRY

FEW DATA HAVE ever been reported to indicate what percentage of the calves in purebred herds eventually become productive animals and what percentage are lost by death or slaughter. The records of the Michigan State College dairy heard have been compiled and analyzed to provide some facts on this phase of dairy herd management. The five breeds, Ayrshire, Swiss, Guernsey, Holstein and Jersey, are maintained in the herd. The study embraced the 19-year period from August 1929 to July 1948.

Table 1 gives the data on the heifer calves that survived birth and were then carried to some eventual disposition. The heifers were mostly retained as herd replacements; some were sold for dairy purposes. On the other hand, some died, others were vealed, and others while carried further had to be disposed of by slaughter before they reached freshening.

TABLE 1—*The ultimate disposition of heifer calves that were born alive—expressed as percentages*

Breed	Number born alive	Percentage that:			
		Entered milking herd	Were sold for dairy purposes	Were vealed or slaughtered	Died
Ayrshires	83	83.1	7.2	1.2	8.4
Swiss	89	80.0	15.7	0	4.5
Guernseys	98	80.6	5.1	1.0	13.3
Holsteins	193	70.5	20.2	4.7	4.7
Jerseys	135	81.5	2.2	2.9	13.3
All breeds	598	77.8	11.2	2.5	8.5

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During the entire period 598 heifer calves were born alive. The Ayrshires showed the highest percentage entering the college milking herd, i.e. 83.1 percent. Only 70.5 percent of the Holsteins entered the milking herd. However, 20.2 percent of the Holsteins were sold for dairy purposes. Any herd operator will recognize this latter figure signifies relative ease in maintaining herd numbers and the consequent good fortune in having numerous heifers that can be spared and sold to enhance the herd income.

Similarly with the Swiss, 15.7 percent were sold for dairy purposes; they were not needed to maintain herd numbers.

Reasons for vealing or later slaughtering a heifer are variable and depend somewhat on herd policy. In general, no heifer is so disposed of unless she is of questionable outcome and usefulness for her particular herd. Of the heifers in this study, an average of 2.5 percent were vealed or slaughtered.

For deaths the average figure is 8.5 percent. The lowest percentage was 4.5 for the Swiss and up to 13.3 percent for the Guernseys and Jerseys.

The handling of purebred bull calves varies in different herds. Table 2 gives the data about this in the College herd.

Incidentally, attention here is called to the fact that this study showed 610 bull calves were born alive in comparison with the 598 heifers, as shown in Table 1. This confirms most studies with all species that male births slightly exceed the females.

For all breeds 53.4 percent of the bull calves that were born alive were either retained in our herd or sold for breeding purposes. But few, less than 1.0 percent, were retained in our own herd. Many purebred herds, as does Michigan State College, follow the practice of vealing bull calves out of 2-year old cows, which have not yet made production records. Also bulls out of older cows which are of questionable productive capacity are vealed. These facts tend to reduce the percentage of the bull calves that will become herd sires. However, in many herds the proportion of the bull calves that are used or sold for breeding purposes may be considerably higher than the 53.4 percent reported from this study.

In respect to this question, it is noted that only 25.0 percent of the Ayrshire bull calves were sold for breeding. This figure contrasts with 69.1 percent of the Holsteins. In Michigan, Holstein herds are far more numerous than Ayrshire herds. Thus there has been a much greater demand for Holstein bull calves. Furthermore, the production

TABLE 2—*The ultimate disposition of bull calves that were born alive—expressed as percentages*

Breed	Number born alive	Percentage that:		
		Were retained or sold for breeding	Were vealed or slaughtered	Died
Ayrshire	80	25.0	71.3	3.8
Swiss	86	61.6	29.1	9.3
Guernseys	125	50.4	40.8	8.8
Holsteins	178	69.1	23.6	7.3
Jerseys	141	47.5	41.8	10.6
All breeds	610	53.4	38.4	8.2

level of the Holstein cows in the College herd has exceeded that of the Ayrshires; the bull calves have been in greater demand for that reason also.

It is noted that 8.2 percent of the bull calves were lost by death. This is essentially the same as the 8.3 percent for heifers.

BREEDING EFFICIENCY IN THE MICHIGAN STATE COLLEGE DAIRY HERDS

By R. C. LEWIS and RUSSELL E. HORWOOD
SECTION OF DAIRY

ONE OF THE FACTORS determining the size of the dairy income on any farm is the breeding efficiency of the dairy herd. Breeding efficiency is an important factor in determining the calving interval, the number of lactations per cow, the season of calving, and the amount of young stock available for herd replacement or expansion and for sale.

The ideal situation is usually considered one in which cows calve at 12-month intervals; thus permitting a 10-month lactation with a 2-month dry period. This goal is seldom attained even in small herds. The efficient dairyman, however, meets this standard as closely as possible.

There have been several investigations into the breeding efficiency found in large herds.

Dawson (2) studied the record of 2,982 services by 20 sires to fertile cows. There resulted 1,197 conceptions; a ratio of 2.49 services per conception. Erb and coworkers (3) have reported that 1.56 services per conception were required in the Purdue University herd. Morgan and Davis (7) at the Nebraska station found that 2,979 services resulted in 1,375 conceptions or a requirement of 2.16 services per conception. Clapp (1) in an analysis of the Cornell University herd from 1929 to 1945 found that 2.11 services per conception had been required. Hilder and coworkers (4) have reported that the Beltsville herd averaged 2.67 services per conception between 1919 and 1942.

PROCEDURE

A study of the Michigan State College dairy herds has been made to determine the average number of services per conception under both natural and artificial breeding conditions. The study included the Ayrshire, Brown Swiss, Guernsey, Holstein and Jersey herds at

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East Lansing. Also included were the Holstein herd at the Upper Peninsula Station at Chatham and the Kellogg Sub-station Guernsey herd at Augusta, Michigan.

Data were secured on 10 Ayrshire, 10 Brown Swiss, 13 Guernsey, 19 Holstein and 13 Jersey bulls used at Michigan State College, as well as 11 Holstein bulls used at Chatham and 17 Guernsey bulls used at the Kellogg farm.

The study covers a period from 1926 to January 1, 1942 for the Chatham herd; from October 1, 1928 to January 1, 1942, for the Kellogg farm herd; and from August 1, 1929 to January 1, 1949, in the College herd located at East Lansing.

The bulls in the Chatham and Kellogg herds were used for natural service only, while those located at East Lansing were used for both natural and artificial service.

RESULTS AND DISCUSSION

This report included 2,889 natural and 990 artificial services. The 2,889 natural services resulted in 1,368 conceptions; a rate of 2.11 services per conception. The 990 artificial services in the College herd resulted in 376 conceptions, requiring 2.63 services per conception as compared with 2.32 services per conception for the 1,844 natural services in that same herd.

Under natural breeding conditions, the efficiency varied from 1.50 services per conception for the Chatham Holstein herd to 2.71 serv-

TABLE 1—*Breeding efficiency of the College herds*

Breed and location	Number of bulls	Natural			Artificial		
		Number of services	Number of conceptions	Services per conception	Number of services	Number of conceptions	Services per conception
College—Ayrshire	10	280	139	2.01	94	33	2.85
College—Brown Swiss	10	246	116	2.12	163	70	2.33
College—Guernsey	13	386	149	2.59	219	89	2.46
College—Holstein	19	466	214	2.17	257	97	2.65
College—Jersey	13	466	172	2.71	257	87	2.95
Kellogg—Guernsey	17	454	184	2.46	—	—	—
Chatham—Holstein	11	591	394	1.50	—	—	—
Totals	93	2,889	1,386	2.11	990	376	2.63

ices per conception for the Jersey herd at East Lansing. Of the cows bred artificially, the Brown Swiss herd showed the greatest efficiency, with 2.33 services per conception, while the Jerseys were least efficient, requiring 2.95 services per conception.

It is not possible to say, with the limited data here available, whether a breed difference in breeding efficiency exists in these herds. The records indicate, however, that the Jerseys and Guernseys were less efficient breeders than the Holsteins, Brown Swiss, or Ayrshires when bred naturally. Lewis (5) found the breeding efficiency of Guernseys to be significantly lower than that of Holsteins in commercial artificial insemination. Guernseys were also found to be less efficient than Holsteins in a study by Mercier and Salisbury (6) at the New York (Cornell) Experiment Station.

Usually the efficiency obtained by artificial breeding will equal that of natural service. Under the conditions found in the College herd, it is not surprising that the breeding efficiency is somewhat lower than is found in artificial breeding units where highly trained personnel and the best of facilities are available. In addition, artificial breeding was frequently carried on with bulls of outstanding inheritance even though the semen was of lower quality than would normally be used.

The need for information leading to increased breeding efficiency is evident. Although an average of two services per conception is at present considered to represent good breeding efficiency, a considerable economic loss ensues through failure to get cows in calf at the first service.

Management practices utilizing the best information on breeding, feeding, and disease control will aid the dairyman in maintaining a maximum level of breeding efficiency.

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THE SURVIVAL AND GROWTH OF HYBRID POPLARS IN FOUR MICHIGAN TEST AREAS

By LESLIE W. GYSEL

SECTION OF FORESTRY

NUMEROUS KINDS of hybrid poplars have been tested in the Lake States during the last 14 years to determine the survival and growth rate on various sites. Rudolph[1] in his summary of hybrid poplar plantings in the Lake States has reported nine experimental hybrid poplar tests which were made by public and private agencies.

In April 1942, the Department of Forestry of Michigan State College initiated a series of hybrid poplar experiments in cooperation with the Dow Chemical Company of Midland, Michigan. The hybrid planting stock was furnished by the company.[2] The experimental design and the planting were carried out under the direction of the college staff. Field measurements and observations of the plantings were made in the spring and summer of 1948.

PARENTAGE OF THE HYBRID POPLARS TESTED

The hybrids tested in this experiment are designated by a number. The parent plants for each of the hybrids are as follows :

No. 30—*Populus maximowiczii* Henry X *P. berolinensis* Dipp.
No. 31—*P. nigra* L. X *P. laurifolia* Ledeb.
No. 48—*P. canadensis erecta* (Selys-Longchamps) Rehd.
No. 52—*P. charkoviensis* Schroed. X *P. nigra plantierensis* (Simon-Louis) Schneid.
No. 69—*P. angulata* Ait. X *P. berolinensis* Dipp.
No. 76—*P. nigra* L. X *P. laurifolia* Ledeb.
No. 78—*P. nigra* L. X *P. laurifolia* Ledeb.
No. 97—*P. petrowskyana* Schneid. X *P. caudina* Tenore.

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[1]Rudolph, P. O., Hybrid poplar planting in the Lake States. Lake States Forest Experiment Station Paper No. 14, 1948.

[2]The Dow Chemical Company obtained the hybrids from the following organizations: Nos. 30, 31, 52, 76, 78—Northeastern Forest Experiment Station, Upper Darby, Pennsylvania. Nos. 69, 97—Morton Arboretum, Lilse, Illinois. No. 48—*Highland Park Arboretum*, Rochester, New York.

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DESCRIPTION OF THE EXPERIMENTAL AREAS AND THE EXPERIMENTAL DESIGN

Test plantings were made in four areas which have distinctly different site conditions.

THE DUNBAR FOREST EXPERIMENT STATION

The most northerly of the experimental areas is at the Dunbar Forest Experiment Station which is located approximately 16 miles southeast of Sault Ste. Marie, Michigan.

Experimental plantings were made on two separate sites within the station area. Site I is a level meadow with two soil types, Bergland clay loam and the Brimley very fine sandy loam, which cover about equal parts of the area. Both soils tend to be excessively wet in wet weather; high water stands on the surface of the Bergland but not on the Brimley. Natural vegetation before planting was composed of a heavy cover of grasses and sedges.

Site II is a part of an old field located on a slight knoll which is elevated one to three feet above the surrounding area. The soil type is a Rubicon sand.

On site I approximately 25 cuttings of each hybrid were planted in one section of a row which contained two or three hybrids. The block was prepared for planting by plowing in 1941, harrowed several times and replowed, leaving narrow ridges between dead furrows which were about 8 feet apart. The trees were planted on the ridges 6 feet apart in the rows.

On site II, approximately 25 cuttings of each hybrid were planted 6 feet apart in rows 6 feet apart. The block was prepared for planting by plowing shallow furrows just before planting. The cuttings were planted in the furrows.

Plots on both sites were hoed during the first and second seasons after planting.

THE MANCELONA PLANTATION

The hybrid poplar plantings are a part of the forest plantation area located one-half mile north of the town of Mancelona, Michigan. Plantings were made on two contiguous blocks which have the same site conditions. The topography is gently undulating and the soil type a Kalkaska loamy sand. The area was an old field with a sparse grass cover.

Two treatments were used in this area. In one block the ground was plowed and fitted before planting and cultivated with a hoe for one season after planting. In the adjacent block, furrows were made in which the trees were planted. No other treatment was given to this block. The trees were planted 6 feet apart in rows with approximately 12 to 13 trees of each hybrid per row. Two rows were 6 feet apart with an 18-foot strip separating each double row.

THE LAKE CITY EXPERIMENT STATION FARM

This area is located approximately one mile south of Lake City, Michigan. The hybrid poplar plantings were made on a slightly sloping old field which had a grass cover. Two soil types occur in the plantation area, Newton sand on the lower portion and Ogemaw sandy loam on the higher portion of the site.

One block was plowed and fitted before planting and cultivated for two seasons after planting. Approximately 25 cuttings of each hybrid were planted in rows with a 6-foot spacing between trees and rows.

THE KELLOGG FOREST

The hybrid poplar plots located in this tract, which is two miles north of Augusta, Michigan, are the most southerly of the experimental plots. Plantings were made on two separate and different types of sites. Site I is located on flat, moderately well-drained land which is approximately at the base level for the general area. The soil type is Oshtemo sandy loam. Site II is a flat, well-drained hilltop area, about 100 feet higher than site I, on which the soil type is Bellefontaine sandy loam.

On site I two treatments were tested. One-half of the area was plowed and fitted before planting and the other half was furrowed only. Cuttings were placed in the furrows. Five rows of each hybrid were planted with five trees per row. Each treatment block was rectangular in shape, with four contiguous plots of hybrids per side and two plots wide.

Only one treatment was tested on site II. The block was plowed and fitted before planting. The plot design was the same as that in site I with 25 trees in each plot.

Both blocks which were plowed and fitted before planting were also cultivated for two years after the planting.

TABLE 1—*The total survival of the hybrid poplars expressed as a percentage of the number planted*

Hybrid number	Test areas								Mean
	Dunbar Station		Mancelona Plantation		Lake City Farm	Kellogg Forest			
	Site and treatment								
	I–PC*	II–FC	I–PC	I–F	I–PC	I–PC	I–F	II–PC	
30	76	—	100	100	44	84	24	92	74
31	100	76	85	100	92	96	96	76	90
48	56	19	83	100	38	96	28	96	65
52	67	32	92	100	52	72	20	44	60
69	76	8	100	93	5	60	28	88	57
76	84	84	92	100	42	88	68	88	81
78	83	—	92	100	36	76	84	56	75
97	76	12	92	100	56	92	28	24	60
Mean	77	39	92	99	46	83	47	71	

*The Roman numeral is the site number; P–designates plowed, C–cultivated, and F–furrowed treatments.

THE GROWTH AND SURVIVAL OF HYBRID POPLARS IN THE TEST AREAS

TOTAL SURVIVAL—(Table 1)

Only one hybrid, number 31, survived relatively well in all of the planting areas, although some of the other hybrids had better survival in individual plots.

Survival was predominately the best in the Mancelona area although the growth was relatively poor. It is also interesting to note that survival in the furrowed plots of this location was slightly higher than in the plowed and fitted plots. This was not the case in the other areas. It is possible that on the sandy soil of the area that this better survival was due to a greater amount of available moisture in the furrows than on the even plowed surface.

SURVIVAL OF THE ORIGINAL STEMS—(Table 2)

An analysis of the number of original stems surviving was made because it is an important phase of the early growth and development of the hybrid poplars included in this study. Various environmental factors such as frost, fungi, rodents, and insects may kill the original stems. Multiple-sprout growth often results after the original stem dies (Fig. 1). The height and diameter of the sprouts are generally

TABLE 2—*The survival of original hybrid stems expressed as a percentage of total number of surviving stems of each hybrid*

Hybrid number	Test areas								Mean
	Dunbar Station		Mancelona Plantation		Lake City Farm	Kellogg Forest			
	Site and treatment								
	I–PC*	II–FC	I–PC	I–F	I–PC	I–PC	I–F	II–PC	
30	53	—	92	91	99	100	0	100	76
31	0	42	100	91	36	100	29	100	62
48	0	0	50	62	22	100	29	100	45
52	19	0	75	67	23	100	40	100	53
69	0	0	16	84	100	100	0	100	50
76	0	67	55	100	60	100	30	100	64
78	16	—	18	69	78	100	14	100	56
97	37	33	64	100	64	100	0	100	62
Mean	16	24	59	83	60	100	18	100	

*The Roman numeral is the site number; P–designates plowed, C–cultivated, and F–furrowed treatments.

much smaller than those of the original stems. It is also possible to assume that the sprouts will be repeatedly affected by the agents which injured or killed the original stems.

Fig. 1. Multiple sprouts near the base of a dead original hybrid poplar stem at the Dunbar area.

Approximately 60 percent of all shoots of the surviving hybrids were original. The remaining 40 percent were killed and subsequently sprouted at or near the root collar. All original stems of any one hybrid did not survive in all plots, although almost all of the surviving stems of hybrids 30 and 31 were original in the plowed and fitted plots of the Mancelona and Kellogg areas.

All of the surviving stems in both plowed and fitted plots of the Kellogg area were original; however, the survival in these Kellogg plots was only 83 and 71 percent, respectively. A relatively large number of original stems also survived in the Mancelona plots, where the total survival was high.

AVERAGE HEIGHT—(Table 3)

The average height of the original stems was greater than that of the sprouts in all areas.

The height growth of all hybrids in the plowed and fitted blocks of the Kellogg area was outstanding when compared with the furrowed block in the same area and also to blocks in other areas (Fig. 2 and 3). This was apparently the result of the better site conditions of the Kellogg area and treatment.

TABLE 3—*The average height of original stems and sprouts in feet*

Hybrid number	Test areas: Dunbar Station				Mancelona Plantation				Lake City Farm		Kellogg Forest						Mean	
	Site and treatment: I–PC*		II–FC		I–PC		II–F		I–PC		I–PC		I–F		II–PC			
	O**	S	O	S	O	S	O	S	O	S	O	S	O	S	O	S	O	S
30	9	2	—	—	9	—	9	7	14	7	23	—	—	3	18	—	14	5
31	—	2	2	1	5	—	6	6	6	3	15	—	4	5	19	—	8	3
48	—	3	—	1	6	3	6	5	9	4	19	—	8	4	21	—	12	3
52	12	2	—	1	8	4	8	5	9	3	21	—	3	3	15	—	11	3
69	—	1	—	1	6	4	6	6	10	—	16	—	—	1	17	—	11	3
76	—	2	3	1	5	5	7	—	5	3	17	—	5	3	21	—	9	3
78	13	1	—	—	5	4	7	6	6	5	19	—	7	4	17	—	11	4
97	10	2	1	1	7	5	8	5	10	6	19	—	—	2	13	—	10	4
Mean	11	2	2	1	6	4	7	6	9	4	19	—	5	3	18	—		

*The Roman numeral is the site number; P–designates plowed, C–cultivated, and F–furrowed treatments.

**O–original stems, S–sprouts.

Fig. 2. A corner of a plot of hybrid 48 on site II at the Kellogg Forest. The average height for the plot was 21 feet and average diameter 3.1 inches.

Fig. 3. A general view of the furrowed block at the Mancelona plantation. The survival was almost 100 percent, but the average height growth was only 6½ feet.

TABLE 4—*The average d.b.h. of all trees in the plowed and fitted plots of the Kellogg Forest*

Site	Hybrid number								Mean
	30	31	48	52	69	76	78	97	
	inches	*inches*	*inches*	*inches*	*inches*	*inches*	*inches*	*inches*	*inches*
I.....	3.2	2.2	2.7	3.0	2.2	2.3	2.3	2.2	2.5
II.....	2.5	2.7	3.1	1.9	2.5	2.7	2.2	1.7	2.4

AVERAGE DIAMETER—(Table 4)

Diameter measurements of the hybrids were made in the two plowed and fitted plots of the Kellogg area only, because the trees in both plots were all original stems and had relatively large diameters. In the plots of other areas only four trees (in the Lake City area) had a d.b.h. of 2 inches or over.

FACTORS AFFECTING SURVIVAL AND GROWTH

No attempt was made to determine the exact factors which affect survival and growth of the hybrids; this would be a complex problem because of the number of hybrids, treatments, and sites involved. During the field survey, however, a few of the more obvious factors were noted. These are listed for each area as follows, in order of importance:

Dunbar Station—freezing damage, borer damage,[3] canker damage.
Mancelona Plantation—freezing damage, canker damage.
Lake City Farm—canker damage, borer damage.
Kellogg Forest—canker damage, freezing damage.

It was noted that all hybrids were affected by the canker. The number of stems infected varied with the area; the Dunbar area was least affected. Fifty percent or more of the trees in each of the other plots were affected by canker; in the plowed and fitted plots of the Kellogg area, all hybrids except one had a 100-percent infection (Fig. 4).

Survival and growth may also be influenced by soil factors. A number of widely different soil conditions occur in the test areas. The Bergland clay loam of the Dunbar area is heavy and often excessively

[3]The borer damage is caused by *Cryptorhynchini lapathi L.*

Fig. 4. A broken original stem of a hybrid poplar in the plowed and fitted block of site I at the Kellogg Forest. The break occurred at a section of the stem which had been weakened by canker damage. Many trees in some of the plots were seriously injured in this way.

wet during the spring. On the other hand, the Rubicon sand, the Kalkaska loamy sand, and the Newton sand are light soils and may become excessively dry during the summer season. Both the Oshtemo sandy loam and the Bellefontaine sandy loam of the Kellogg area are the best of the soils in textural qualities.

Climate must also be considered in an analysis of factors affecting growth and survival. The shorter growing season and the lower mean temperature may place the northern test areas at some disadvantage in causing severe freezing damage and limiting growth in comparison with the southern Michigan plots.

SUMMARY

A study of the survival and growth of eight hybrid poplars was made after six growing seasons in four test areas in Michigan.

For each hybrid, the total survival was marked by large differences

between test areas and plots. A comparison by test areas showed the survival to be best in the Mancelona plantation where the average for two blocks was 96 percent. Hybrid 31 had the best average survival for all plots.

It was found that an average of approximately 60 percent of the stems surviving were original; the remaining were sprouts. All of the surviving stems in the plowed and fitted plots of the Kellogg area were original.

The average height and average diameter of the hybrids in plots other than those of the Kellogg area were low values. In the plowed and fitted plots of the latter area, the average height of all hybrids was 19 feet and the average d.b.h. 2.5 inches.

Some of the factors affecting growth and survival were borer damage, canker damage, climate, and soils.

Under the conditions of this experiment, the hybrids tested apparently will be of possible commercial value only in the southern Michigan test area, the Kellogg Forest, on ground which was plowed and fitted before planting and cultivated after planting. Here, on the basis of superior height and diameter growth, hybrids 30 and 48 were the best; however, both were highly infected with the fungi causing canker damage which may affect the future survival and growth.

A STUDY OF SOME FACTORS AFFECTING DETERMINATION OF WATER REPELLENCY IN TREATED WOOD

By R. W. LA BERGE and A. J. PANSHIN
SECTION OF FORESTRY

THE CONTINUED popularity of wood for all types of construction, as well as for furnishings in private residences and commercial buildings, attests to the inherent excellence and high versatility of this material. Yet it is a well known and frequently a very disconcerting fact that many moving parts such as windows, doors and drawers may refuse to function properly during certain seasons of the year. Many other structural units may be similarly affected, leading to even more serious trouble, such as, for instance, cracking of plaster or buckling of floors. In each case the trouble is traceable to the changes in wood dimensions which accompany changes in its moisture content.

It is logical, therefore, that considerable research has been directed toward finding some means of correcting this peculiar behavior of wood. Although many different approaches to stabilization of wood are possible, one of the most practical methods is to treat the wood with the so-called water repellents.

Because there are so many products of this nature now on the market it becomes necessary to provide means for determining their effectiveness. The commonly used laboratory method for such evaluation involves dipping, and subsequent exposure to various humidity conditions, of small samples of ponderosa pine. The change in dimensions, when compared with untreated standards, serves to measure the effectiveness of a product as a water repellent. The technique for such testing, however, is far from being standardized, with the result that direct comparison of the findings obtained by various investigators is seldom possible.

The purpose of this study is to evaluate some of the variables in the laboratory procedures that may affect the reliability of testing

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technique. Specifically this investigation was confined to determination of 1) the effect that the size of the sample and the length of the treating period may have on the absorption of a water repellent by the samples; 2) the effect of specific gravity of wood on the percent absorption of a repellent; 3) the effect of varying sample size and lengths of treating period on the efficiency of a repellent.

THE REASONS FOR INSTABILITY OF WOOD

The instability of wood, as characterized by its tendency to change size, is due basically to the hygroscopic nature of wood substance, i.e., to the affinity of wood for moisture. In this respect wood behaves similarly to a colloidal substance. It will take moisture from its surroundings or lose it to them, depending on its moisture content and the temperature and relative humidity of the atmosphere. This absorption or disorption continues until the moisture content of the wood and that of the surroundings are in balance with each other; this condition is termed equilibrium moisture content.

Moisture in green wood occurs in two forms: as free moisture in the cell cavities and as bound or absorbed moisture in the cell walls. When wood is being dried, free moisture is removed first. The fluctuations in the amount of free moisture have no effect on the stability of wood, since they are not accompanied by any dimensional changes. Upward or downward changes in the amount of bound moisture produce corresponding dimensional changes. Wood swells when the amount of bound moisture is increased, and shrinks when it is decreased. The fluctuations in moisture content of wood, and hence in its dimensions, will continue until an equilibrium between the moisture content of wood and that of the surroundings is reached. In actual practice, since atmospheric conditions fluctuate constantly, such an equilibrium is never reached.

The magnitude of dimensional changes in the wood, therefore, is related directly to the extent of fluctuations in the temperature and the humidity of the surrounding atmosphere. In the winter, for instance, in a heated house, wood will dry and shrink until it reaches a low point of about 6 percent moisture content. After this only very small variations, corresponding to changes in temperature and humidity of the air within the house, will occur. Such dimensional fluctuations will generally be so small that by and large they pass unnoticed. With the advent of warmer weather and discontinuance of artificial heating, the moisture content of wood in a house will tend to increase until a new

equilibrium is reached with the much more humid summer air. This may result in a seasonal gain of 4 to 6 percent in moisture content of the wood. The corresponding changes in dimensions are great enough to cause considerable trouble, or at least annoyance.

MATERIAL AND METHOD OF PROCEDURE

Sapwood of ponderosa pine (*Pinus ponderosa* Dougl.) was used in all tests. The boards were flat-sawn and were selected for average density, number of growth rings per inch and grain alignment. The lumber was planed to ½ inch thickness, and cut into samples 1½ inch wide and 2, 3, 4 and 5 inches long, along the grain. The test samples were then placed in a conditioning chamber for a period of 2 weeks, at the end of which time an equilibrium moisture content of 3.2 percent was reached.

Two widely used commercial repellents were employed in the tests. Prior to the treatment with a repellent the samples of each size group were weighed and divided into groups of 50, in such a manner that each group would contain the same range of specific gravities. These size groups were further subdivided into groups of 10. Again special attention was paid to having samples of different densities included in each group. In effect, therefore, each group of 10 samples represented the same range of densities.

Each group of 10 matched samples was treated with a repellent for 15 seconds, 1 minute, 3 minutes, 30 minutes and 1 hour, respectively. During the immersion the repellent solutions were agitated with a 60-cycle Fultork motor, to reduce the surface effect between the wood and the solution. This was done because preliminary tests showed that stirring of the solution results in an increase of absorption. At the completion of the treating period the samples were wiped and weighed on a torsion balance. The increase in weight was recorded, and from that the net percent of absorption determined.

DISCUSSION OF TREATING DATA

EFFECT OF LENGTH OF DIPPING PERIOD ON ABSORPTION OF REPELLENTS

When absorption in percentage is plotted against time in the treating solution (Fig. 1) it is evident that the greater absorption takes place in a relatively short time, generally in the first 10 or 15 minutes. This rapid initial absorption may be attributed to the porous nature of wood

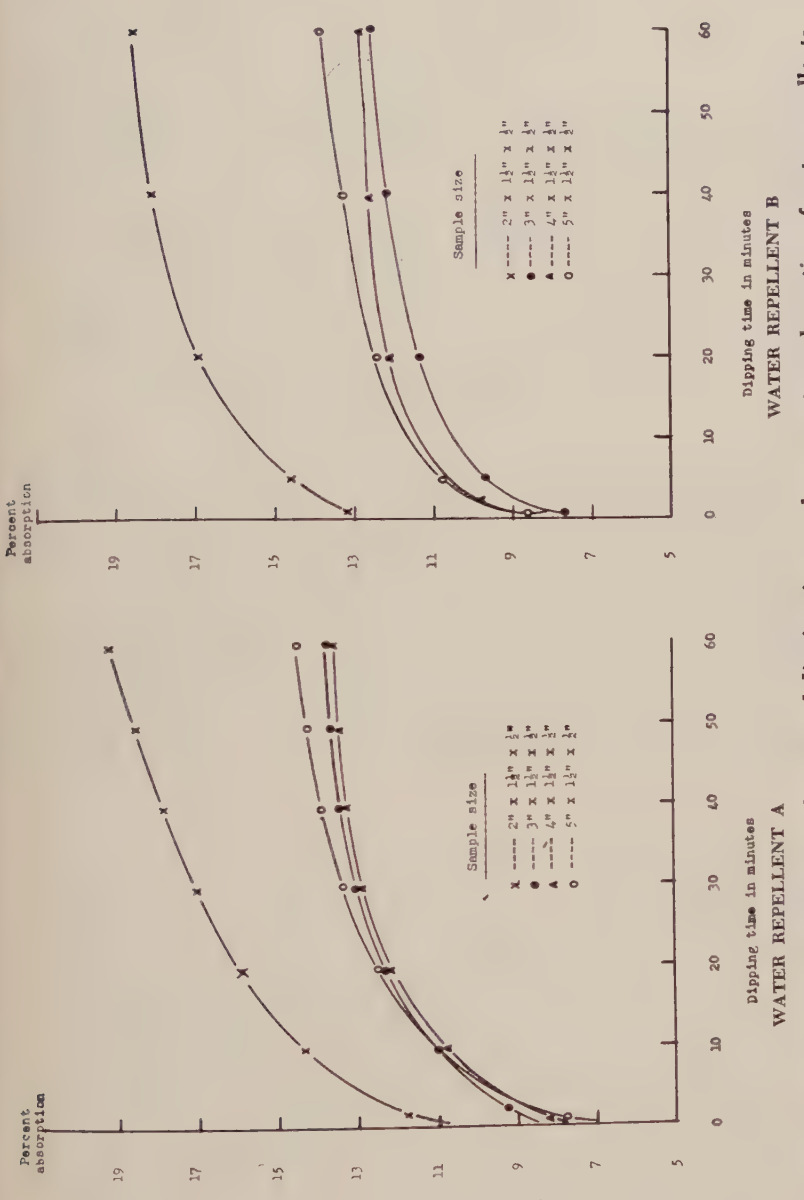
Percent absorption
Dipping time in minutes
WATER REPELLENT A
WATER REPELLENT B
Sample size
X ---- 2" x 1½" x ¼"
● ---- 3" x 1½" x ¼"
▲ ---- 4" x 1½" x ¼"
O ---- 5" x 1½" x ¼"

Fig. 1. Effect of varying the sample size and dipping time on the percentage absorption of water repellents.

and dry condition of the test samples. Further penetration of the repellent is apparently retarded by the entrapped air in the wood, creating a back pressure. The structural characteristics of wood, such as pits, may also be responsible for setting up barriers to the free flow of liquids through the wood.

EFFECT OF LENGTH OF SAMPLES ON ABSORPTION OF REPELLENTS

The same curves (Fig. 1) also reveal the effect of sample length on the percent absorption. The 2-inch samples show considerably greater absorption than the longer pieces. Increase in length of samples beyond 2 inches results in considerable decrease in absorption. The percentage absorption remains then nearly constant for the lengths of samples used in tests, i.e., there seems to be no appreciable difference in percent absorption in samples of 3, 4 and 5 inches in length.

EFFECT OF SPECIFIC GRAVITY OF WOOD ON ABSORPTION OF REPELLENTS

To test the possible effect of the specific gravity on the percent absorption of a repellent, 3-inch-long samples only were used. These samples were segregated into four specific gravity ranges, as follows: 0.3853 through 0.4127, 0.4128 through 0.4403, 0.4404 through 0.4678, and 0.4679 through 0.4954. All the samples were dipped in an agitated repellent solution for 10 minutes. The amount of absorption was determined by weighing, and the results plotted. The curve in Fig. 1 indicates the existence of a relationship between the percent of absorption of the repellent and the specific gravity of the wood. The lighter

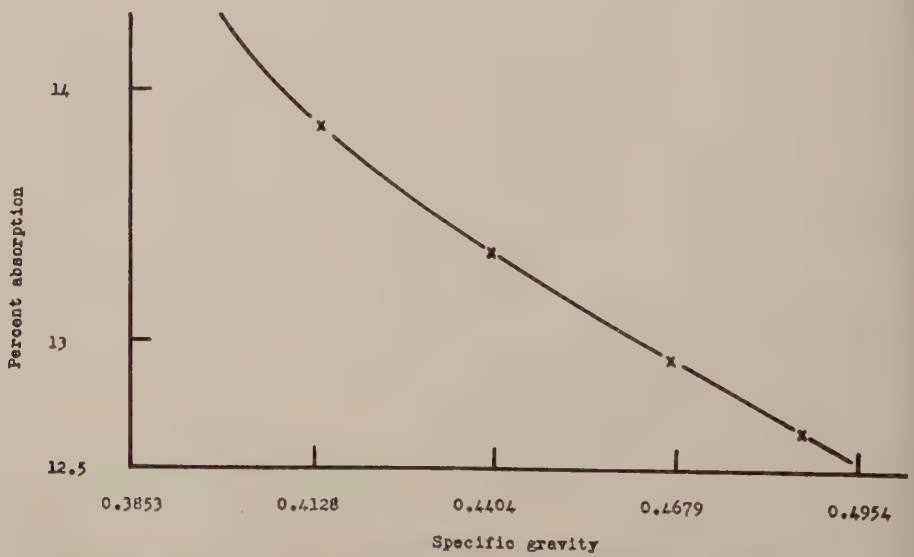

Fig. 2. Effect of varying the specific gravity on the percent absorption of water repellent B.

the wood, the greater is the absorption. The effect of specific gravity is more pronounced at the lower ranges of specific gravity values. It is quite evident from these data that a definite specific gravity range should be used, if valid comparisons are to be made between different determination.

DETERMINATIONS OF EFFICIENCY OF A WATER REPELLENT

The purpose of this study was to determine what effect the increase in length of samples and prolongation of treating time may have on the water repellent efficiency of the two products used in these experiments.

The water repellent efficiency of each repellent, designed *A* and *B*, was determined from the following formula:

$$\text{Percent efficiency of water repellent} = \frac{\text{Change in dimension of untreated control sample} - \text{Change in dimension of treated sample}}{\text{Change in dimension of untreated control sample}}$$

The control samples and the treated samples were first conditioned at room temperature for 30 days. At the end of this period their width

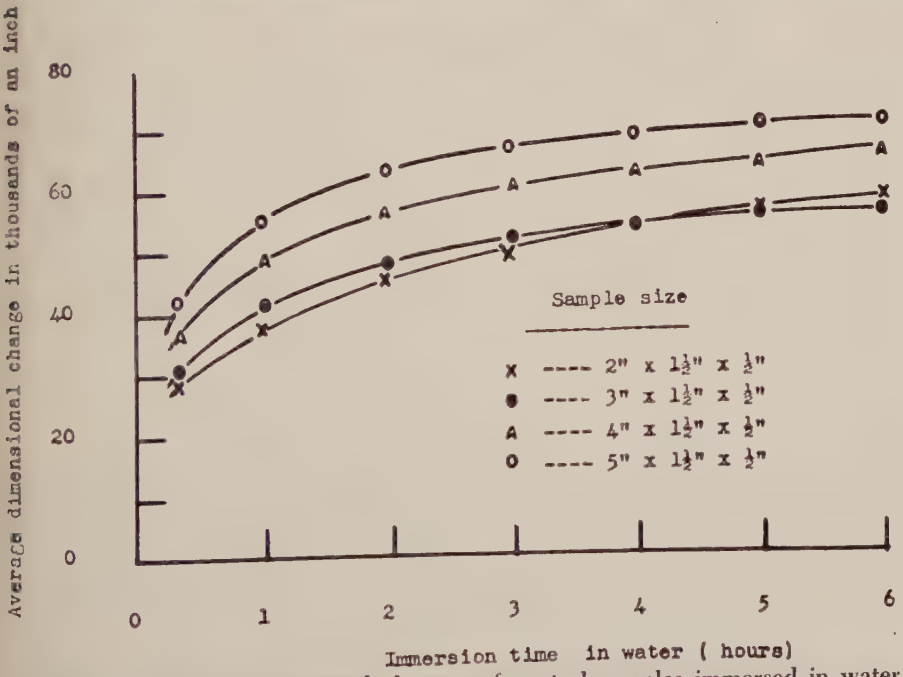

Fig. 3. Average dimensional changes of control samples immersed in water for varying periods of time.

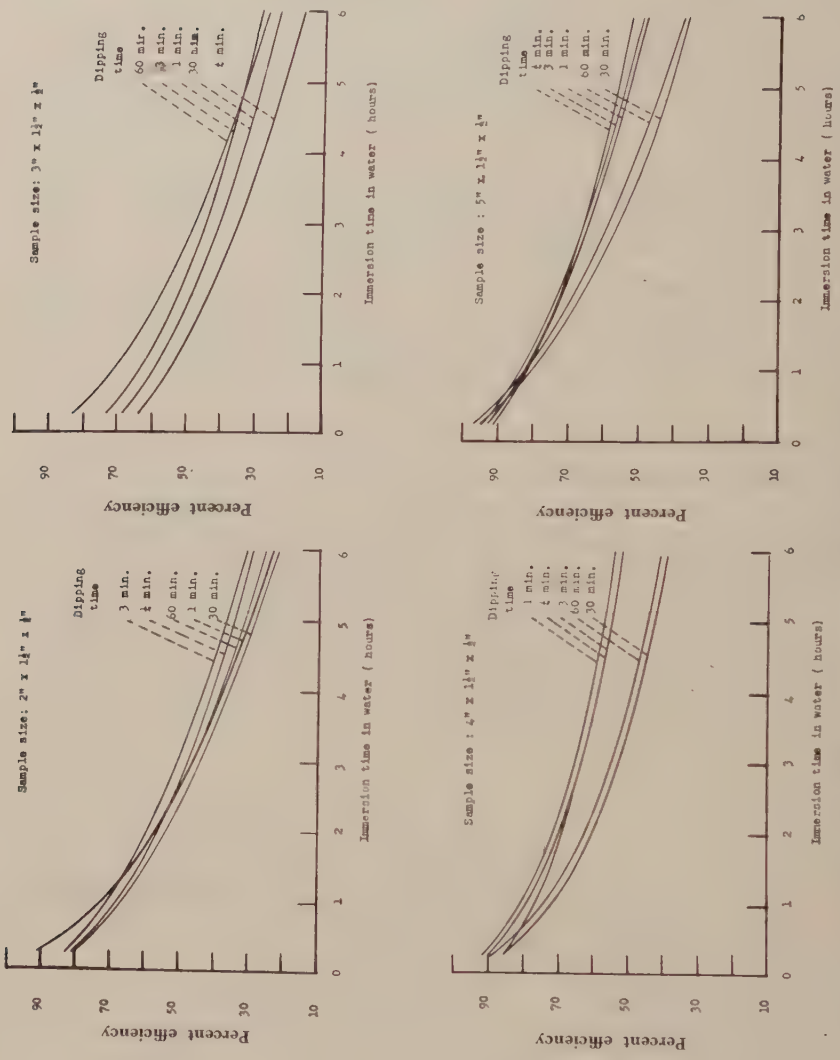

Fig. 4. Average percent efficiency of water repellent A, as affected by sample size and dipping time.

(tangential dimension) was measured with an extensometer to the nearest ten thousands of an inch. The controls and the treated samples were then placed in a tank filled with water. The temperature of the water was kept constant by means of thermostatically controlled heating coils. The changes in dimension were determined every 15 minutes for a period of 6 hours.

The results, when plotted, indicate (Fig. 3) that for control samples the longer the sample, the greater the dimensional changes for each

period of immersion. The most rapid changes in dimension take place in the first 2 hours of immersion.

In treated samples, varying the length of treating time in a repellent from 15 seconds to one hour had a relatively small effect on the water repellent efficiency in any given size group, as indicated by the analysis of variance. This is particularly true for the shorter periods of water immersion. Somewhat greater efficiency was indicated for samples treated with water repellents for longer periods of time and subjected to longer intervals of water immersion (Fig. 4).

The overall repellent efficiency for the two products tested ranged from 75 percent for the shorter pieces to 92 percent for the longer samples, for a 15-minute water immersion period. The efficiency decreased rapidly as the length of immersion period was increased. After 6 hours of water immersion the efficiencies had declined to 25 percent for the shorter pieces and a maximum of 60 percent for the longer samples.

SUMMARY AND CONCLUSIONS

The following factors that may affect the validity of the laboratory technique of measuring efficiency of a water repellent were studied.

1. Effect of varying the sample length and treating time on the percent absorption of two commercial water repellents.

2. Effect of varying the specific gravity of wood used for test samples on the percent absorption of a water repellent.

3. The water repellent efficiencies of the two products, as indicated by dimensional changes in the test samples, following immersion in water from 15 minutes to 6 hours, were determined.

4. Effect of varying, the sample length and the length of treating time in a repellent were correlated with the water repellent efficiency of the product.

The results of these tests indicate that:

1. Absorption of a repellent is directly correlated with the specific gravity of wood used for test samples. The lighter the wood, the greater is the percentage absorption.

2. The percentage absorption of a repellent is affected by the temperature of the wood and of the repellent solution, as well as by the moisture content of the wood. Therefore the condition of samples and the treating solution should be standardized in relation to these factors.

3. Greater absorption of repellents can be obtained when a solution is agitated.

4. Rapid absorption of a water repellent occurs the instant dry wood comes in contact with the solution. About 60 percent of the total absorption takes place during the first hour of dipping. The rate of absorption decreases as the time of dipping increases.

5. Increase in the length of samples from 2 to 3 inches results in an appreciable decrease in the percent of absorption of a repellent. Increase in the sample length beyond 3 inches produced further decrease in the percentage absorption, but at a much slower rate. This was due largely to the effect of end-grain penetration that becomes less important as the length of the sample increases.

6. After immersion in a water-bath the average dimensional changes of untreated control samples increased with increase in the sample length, while those of treated samples decreased.

7. The average changes in dimensions of treated and untreated samples, as a result of water immersion, were greater for the first 2 hours of immersion than for the following 4 hours.

8. Varying the treating time in a repellent from 15 seconds to one hour had relatively little effect on the subsequent water repellent efficiency for any given sample-length group.

9. It is concluded from these tests that in developing a proper testing technique for evaluation of water repellent efficiency of a product, special attention should be paid to the specific gravity and the length of the test samples. The procedures should also be standardized in regard to the moisture content of the test samples at the time of treating, and the temperature of wood and the solution during the water immersion test.

MARKETING EGGS THROUGH A GRADING STATION

By L. E. DAWSON and J. A. DAVIDSON[1]
SECTION OF POULTRY HUSBANDRY

UNTIL RECENTLY most farmers received the same price for each dozen eggs sold, regardless of quality. Egg buyers sometimes purchased eggs on the basis of "case weight", but the practice is relatively new of weighing and sorting each egg into a grade according to its size and quality, and paying producers according to these grades.

Previous to 1937 few eggs were being purchased on a graded basis, and considerable variation existed between grades in different areas. The quality of a single grade also varied throughout the year depending on the supply of eggs and the average quality of all eggs available.

A federal-state egg grading service has been operating in Michigan since 1937. This is a voluntary program in which each cooperator obtains the services of an official egg grader. The grader, an employee of the U.S.D.A., is interested in sorting the eggs according to federal standards which do not vary from year to year or from one area to another.

The first federal-state egg grading station to operate in Michigan is located at Hamilton. This, a farmer's cooperative, has been paying egg producers on a quality basis for more than a decade, and may have been influential in increasing producer's income from the poultry enterprise in the surrounding area. The following discussion is based on an analysis of the grading certificates of this station from 1942 to 1948.

QUALITY AND QUANTITY CHANGES IN EGGS RECEIVED

VOLUME OF EGGS GRADED INCREASES

The number of eggs handled almost doubled from 1942 to 1948. Although the volume remained fairly constant from 1942 to 1945, it

[1]The authors wish to acknowledge the cooperation of A. G. Lohman, and B. Nykamp, of the Hamilton Farm Bureau Cooperative Association, for making the original records available.

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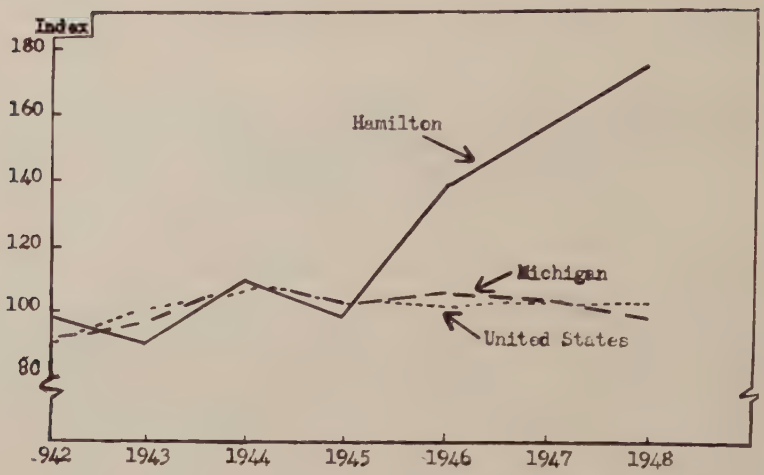

Fig. 1. Index of volume of eggs handled, Hamilton Egg Grading Station, and index of volume of eggs produced, United States and Michigan, 1942-48. (1942-45 = 100)

increased on an average of 14,000 cases a year from 1945 to 1948. Index of volume handled increased from 100 to 175 during this 4-year period. At the same time the index of egg production for Michigan and the United States remained fairly constant (Fig. 1).

MORE EGGS GRADED IN FALL MONTHS

There was a definite change in the seasonal egg marketing pattern between 1942 and 1948. In 1942, 53 percent of all eggs marketed were

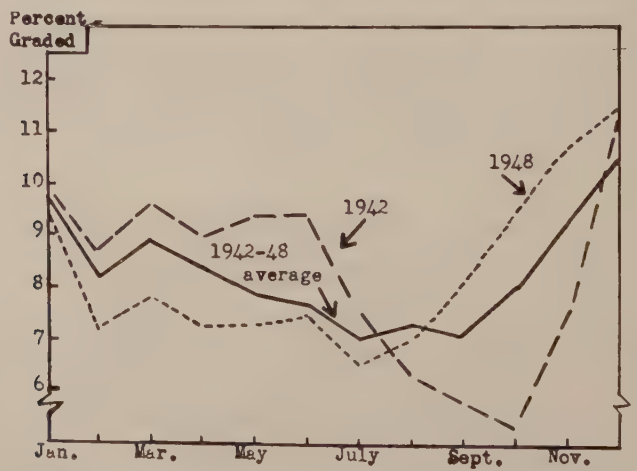

Fig. 2. Seasonal variation in volume of eggs graded at Hamilton, 1942, 1948 and 1942-48 average.

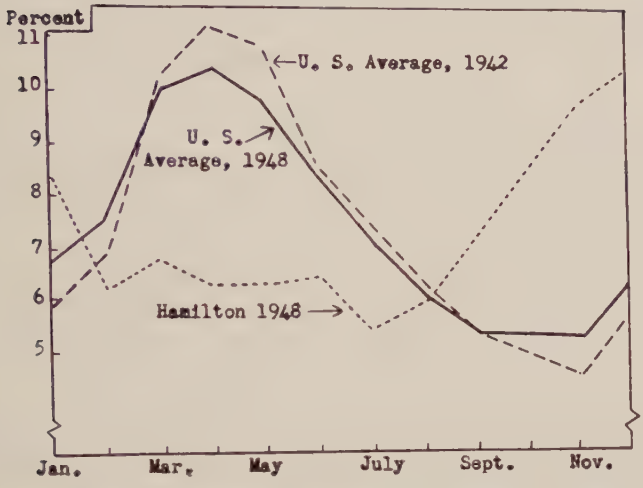

Fig. 3. Seasonal variation in volume of eggs handled, Hamilton Egg Grading Station, 1948, and seasonal variation in egg prodution, United States, 1942 and 1945.

sold in the six months February to July, whereas only 44 percent of the 1948 egg crop was marketed in the same period (Fig. 2).

The increase in fall egg production began in November in 1942, but started as early as August in 1948. This indicates that producers are getting their pullets into production 3 months earlier than they did 7 years ago.

For the United States as a whole, the month of peak egg production is April, and the low month is November. A definite shift occurred in the seasonal production pattern between 1942 and 1948. Production in the peak month was less in 1948 than in 1942 and production in the low month was greater (Fig. 3). Such a shift put more fresh eggs on the market during low production periods, thus lessening the demand for storage eggs.

Figure 3 also shows the seasonal variation in egg production for the United States and for the Hamilton Egg Grading Station in 1948. Farmers in this area are at their peak production 4 months earlier than the average United States producer.

PERCENTAGE GRADE "A" EGGS REMAINS ABOUT CONSTANT

From 60 to 85 percent of the eggs were graded U.S. Grade "A" from March 1943 to December 1948. The fluctuations in percentage of grade "A" eggs appears less severe in the last 3 years than in the period 1943-45, (Fig. 4).

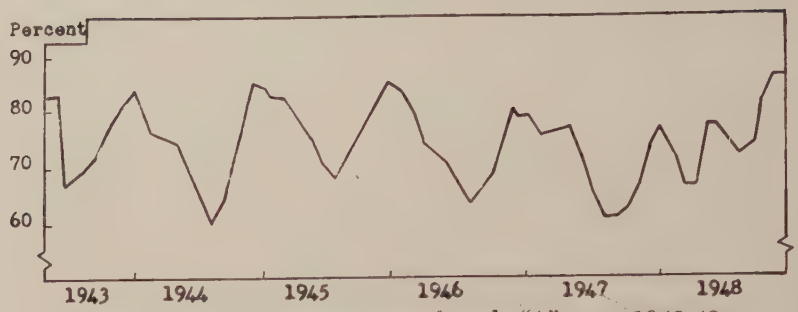

Fig. 4. Variation in percentage of grade "A" eggs, 1943-48

HIGH PERCENTAGE OF GRADE "A" IN NOVEMBER AND DECEMBER

More grade "A" eggs were candled in November and December during the period 1942-48 than in any other month. Lowest percentage of grade "A" eggs occurred in July and August (Fig. 5).

The quality of eggs normally declines slightly as the laying season progresses. Figure 5 shows highest percentage of grade "A" eggs in November and December when more early hatched pullets are laying and when temperatures are lower. In 1948 the seasonal variation was less severe than in 1944 and about the same as the 1942-48 average. The percentage of grade "A" eggs was greater during the summer months in 1948 than in 1944, but was lower in the winter and spring months.

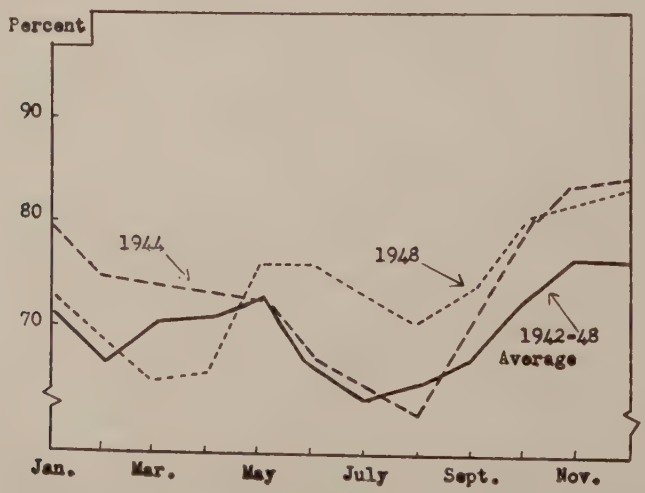

Fig. 5. Seasonal variation in grade "A" eggs 1944, 1948, and 1942-48 average.

Fig. 6. Variation in percentage of checked eggs, 1942-48.

FIFTY-PERCENT INCREASE IN "CHECKS"

In 1942, 4 percent of all eggs graded were classified as "checks". By 1948 over 6 percent were checked (Fig. 6). This represents a substantial loss to the producers. Checks average about 10 cents a dozen less than grade "A" large eggs.

MOST CHECKS IN JULY: FEWEST IN DECEMBER AND JANUARY

A definite seasonal variation exists in the occurrence of checked eggs. During the period 1942-48, 2.5 percent more eggs were checked in July and August than in December or January (Fig. 7).

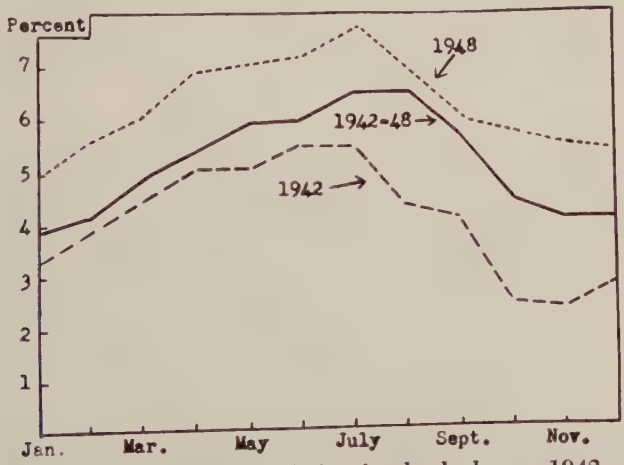

Fig. 7. Seasonal variation in checked eggs 1942, 1948 and 1942-48 average.

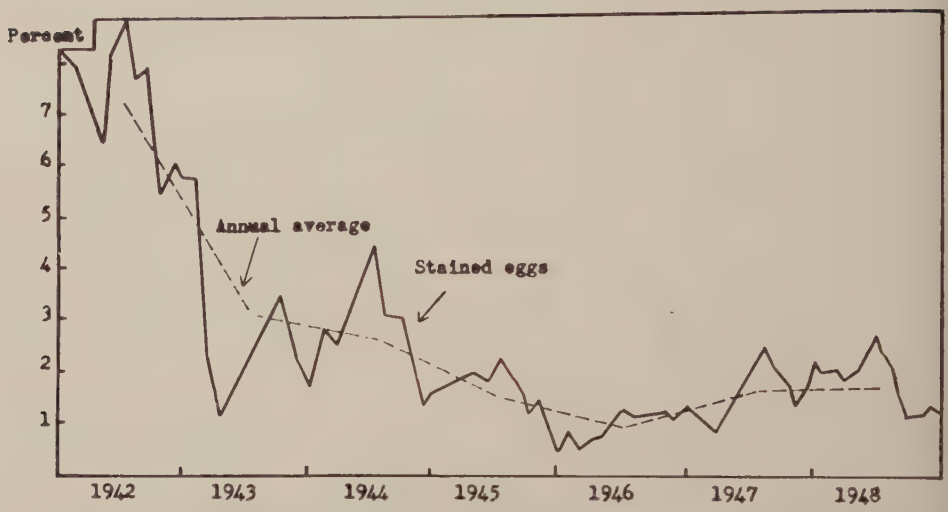

Fig. 8. Variation in percentage of stained eggs 1942-48. In 1942 the percentage of stained eggs varied between 5.7 percent and 9 percent.

PERCENTAGE OF STAINED EGGS DECREASES

In 1942 over 7 percent of all eggs graded were classified as "stained". The following year only 3 percent were so classified, and since 1945 only about 1½ percent were stained (Fig. 8).

The drop in percentage of stained eggs since 1943 may be due to the production of cleaner eggs or to an increase in the practice of

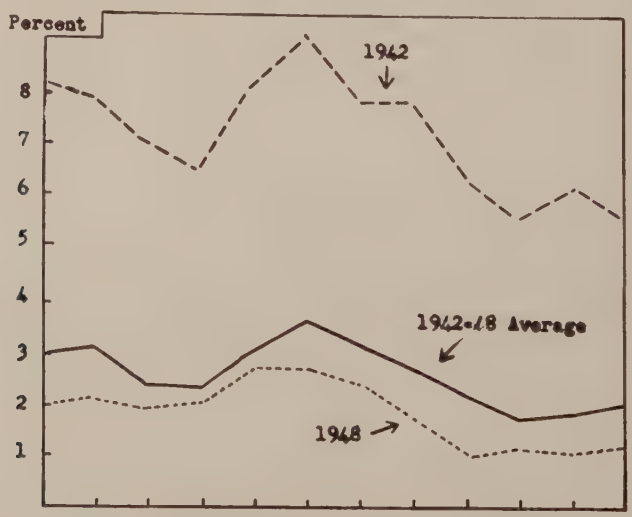

Fig. 9. Seasonal variation in percentage of stained eggs 1942, 1948 and 1942-48 average.

washing eggs. A recent survey indicated that about 70 percent of the producers wash their eggs.

MOST STAINED EGGS IN JUNE: FEWEST IN OCTOBER

The percentage of stained eggs varied between 1.7 percent in October and 3.5 percent in June (1942-48 average). A second minor peak of 3 percent occurred in February (Fig. 9).

FEW EGGS CLASSED AS "LOSS"

About 1½ percent of all eggs graded were classified as "loss" during the entire period 1942-48. The yearly average loss varied little from year to year. Loss includes bloody whites, large blood spots, rots, stuck yolks, and broken eggs.

MORE "LOSS" IN WINTER AND EARLY SPRING: LESS IN SUMMER

A slight seasonal variation exists in percentage of eggs classified as loss. In the 1942-48 average there was a 2 percent loss in May and only 1 percent in August and September (Fig. 10).

AVERAGE EGG SIZE CHANGES LITTLE, 1942-48

Throughout this period about 5 percent of all eggs graded were small, 25 percent were medium and from 42 to 60 percent were large.[2] The percentage of large eggs shown in grading reports was affected not only by weight of eggs produced, but also by an increase in minimum standards for extra large eggs, 1947, which put more eggs in the large grades. The relative prices between extra large and large eggs

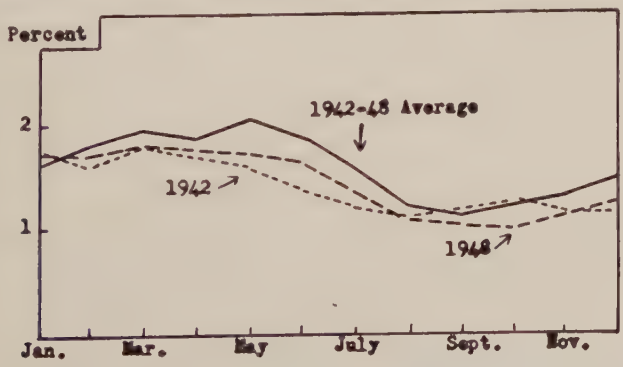

Fig. 10. Seasonal variations in eggs classed as loss 1942, 1948 and 1942-48 average.

[2]Small eggs —minimum net weight per dozen is 18 ounces.
Medium eggs —minimum net weight per dozen is 21 ounces.
Large eggs —minimum net weight per dozen is 24 ounces.

might also affect the number put in either grade. For further analysis as to weight, only medium and small eggs will be used in order to eliminate these other factors.

LARGE SEASONAL VARIATION IN EGG SIZE

The volume of small eggs reached its peak in October in 1942 and 1943, but a month earlier (September) from 1944 to 1948. Volume of medium eggs was highest in November every year.

The number of large eggs increased from October to February, remained fairly constant until May, then decreased rapidly until October.

INTERPRETATIONS

This report is a fore-runner to a study of the factors affecting the production and marketing of better quality eggs. It merely points out some of the changes which have occurred in the quality of eggs produced during the last decade and indicates problems which need further study.

The statement has been made that "producers must be rewarded for their efforts to produce and preserve quality products. The premium paid for high-quality products must be sufficient to induce producers to continue and develop their poultry program."[3] This statement and many other similar ones have often been made when referring to the development or progress of a farmers' marketing cooperative. But why limit it to cooperatives? It should be true of any business organization, and this presentation is based on the services rendered to the egg producers as an egg grading station irrespective of the corporate structure of the business.

Data are not available as to the quality or quantity of eggs produced in this area previous to 1942. This report points out several changes that have occurred since that time, and some relationships in egg production with Michigan and United States.

The volume of eggs produced in the area has increased until the grading facilities of the plant are used to capacity during the fall months. If this trend should continue grading facilities will have to be expanded.

The interior quality of eggs produced has not improved much during this eight year period. However, eggs had been purchased on a

[3]Howland, A., *A Survey of the Cooperative Marketing of Eggs in Michigan*, Michigan Agricultural Experiment Station Quarterly Bulletin, 24 (4) (May 1942): 337.

quality basis in the area for several years, and a high percentage of eggs were already in the top grades.

The percentage of checked eggs has been increasing. This increase may have been caused by any one or a combination of the following: fuller egg baskets; less space per hen; more hens per nest; lack of certain feed nutrients under existing conditions; failure to consider egg shell quality in selection of breeding stock; changes in handling procedures at the grading station; or some other management factor.

Eggs have been coming into the station cleaner than they were 8 years ago. Mechanical egg washers are being used on several farms. Others are washing all or most of their eggs with warm water plus a detergent. Some are probably producing cleaner eggs by using different management practices. Producing clean eggs or cleaning dirty ones is an important economic problem, and certainly deserves further study.

Probably the most important trend, as shown in this report, is the shift in the seasonal egg production pattern. For the United States as a whole the shift is slow, and it will still be several decades before fall and winter production can satisfy consumption. However, the producers in the Hamilton area have taken advantage of this seasonal pattern which has resulted in highest egg prices in the fall and winter, and produce a greater percentage of their eggs from October to January.

Producers in this area have had the advantage of a graded egg market for more than a decade and have thus been induced to develop and expand their poultry programs.

JOURNAL ARTICLE ABSTRACTS

The Formation of Protuberences on Bean Leaves in Response to 2,4-D Treatments

FELBER, IRMA M.

Am. Jour. Botany 35 (9): 555-558. 1948. [*Journal Article 942 from the Michigan Agricultural Experiment Station*]

A formative effect of the action of 2,4-D was observed on bean plants which has not been previously described in literature. Thorn-like protuberances developed on the lower surface of the trifoliate leaves which showed the mosaic-like symptoms subsequent to 2,4-D treatments. The protuberances appeared in a great variety of peculiar form patterns. They ranged in length from 1 to 3 mm, and are covered with small hairs like the normal epidermis. The proliferations originated from spongy mesophyll in the neighborhood of vascular bundles, mostly at the intersections of lateral veinlets. The abnormal tissue consisted of differently shaped and sized parenchyma cells. On the upper surface of such bean leaves the appendages along the undulating veins formed much larger ridges than normally, consisting of parenchyma cells up to 30 layers high.

External factors, light, temperature and humidity had no significant stimulating influence on the formation of the protuberances, but an atmosphere saturated with moisture definitely inhibited their appearance.

The presence of peroxidase in the proliferating tissues was determined by *in vivo* and *in vitro* tests. The result indicated a considerable increase of peroxidase activity in the affected tissues.

An Examination of the Strip Census Method of Estimating Animal Populations

HAYNE, D. W.

Jour. of Wildlife Management 13 (2): 145-157. 1949. [*Journal Article 945 from the Michigan Agricultural Experiment Station*]

The strip census method has been used for estimating numbers of certain game birds and mammals. The observer walks along a pre-determined course and records each animal seen or "flushed", and its distance from his position. From this sample of the entire area, an estimate of the population is computed.

In this paper, use of the method is shown to depend upon certain fundamental assumptions. One of the assumptions is shown to be in error, namely, that the observed flushing distances constitute a good sample of flushing distances throughout the entire population. To avoid this particular error, a modified method of computation is offered, with a mathematical discussion in the appendix.

Certain other possible sources of error are discussed, especially as to testing for their presence. Proper use of the method must be restricted to those situations where the fundamental assumptions appear to conform to the behavior of the animals.

A Study of Methods for the Determination of Sugar in Crop Plants

Waldron, Dorothy R., Ball, C. D., Miller, E. J., and Benne, Erwin J.

Jour. Assn. Official Chemists 31 (4): 708-714. 1948. [*Journal Article 946 from the Michigan Agricultural Experiment Station*]

For a number of years the authors have been concerned with the determination of sugars in a diversified variety of crop plants, including carrot and parsnip roots, onion bulbs, potato tubers, apple, cherry, pear, blueberry and tomato fruits, fruit tree leaves, and various kinds of grain and forage crops. Because of the many problems encountered in sampling, reducing to small pieces and mixing such materials in order to obtain representative portions for analysis, and in extracting, isolating, and evaluating the sugar contained in them, an investigation was undertaken to test the efficiency and reliability of certain practices when applied to the determination of sugars in different types of plant tissues. Carrot roots, onion bulbs, spinach leaves, tomato fruits, and young brome grass were selected as representative crop types, and comparative values for total (reducing plus hydrolyzable) sugar in samples of each were obtained by use of described combinations of a) two methods for extracting the sugars from the tissue, b) two different extracting solvents, c) two methods of hydrolysis, and d) four methods for evaluating the amount of sugar.

The results of the investigation substantiated the following conclusions:

1) A Waring Blendor equipped with improvised blending vessels was convenient and effective for extracting sugars from the crop plants analyzed.

2) Water and 80-percent ethanol could be used interchangeably for extracting sugars from some crop plants, but for others extraction with water gave higher results.

3) Under the same conditions of extraction and hydrolysis, the four methods used for evaluating reducing sugars gave approximately the same result for total sugars in each crop plant analyzed.

4) The use of carbon for clarification of extracts prior to hydrolysis was found to give lower results for total sugars than when the carbon was used subsequent for such hydrolysis.

5) The complexities encountered in the determination of sugars in crop plants necessitate sufficient preliminary work with each different crop to insure that the value obtained with a given analytical procedure represents the true sugar content of the tissue.

Effect of Medium on Resistance of Staphylococcus aureus to Quaternary Ammonium Compounds (P)

Mallmann, W. L., Leavitt, Anita, and Joslyn, Dwight A.

Proc. Soc. Exp. Biol. and Med. 68: 401-403. 1948. [*Journal Article 952 from the Michigan Agricultural Experiment Station*]

Data are presented to show that the resistance of *Staphylococcus aureus* to quaternary ammonium compounds is materially increased by growing the test organisms in Difco "disinfectant testing" broth as compared to standard F.D.A. This effect was found to be due to the presence of a fermentable sugar in the medium.

Growth Potentialities of Vegetative Buds on Apple Trees

FELBER, IRMA M.

Jour. of Agr. Res. 77(9-10): 239-252. 1948. [*Journal Article 968 from the Michigan Agricultural Station*]

A study was made to determine the extent to which the size of individual leaves on the shoots of the apple influences the sizes of their axillary buds and in turn the extent to which bud size is correlated with later performance. Studies were confined principally to the Stark and Northern Spy varieties. It was found that for the first 6 or 8 weeks of the growing season size of axillary leaf bud is not closely correlated with size of its subtending leaf. As the season advances the degree of positive correlation increases, resulting in a fairly high correlation at its close. Relatively large vegetative buds differentiate a larger number of leaf primordia than medium sized or small buds. The larger the bud the more likely is it to develop into a shoot or spur the following season; the smaller it is, the more likely is it to remain dormant. Spurs developing from large buds are likely to have more leaves than those developing from medium or small buds.

Transmissible Gastroenteritis of Baby Pigs

FEENSTRA, E. S., THORP, F., JR., GRAY, M. L. AND MCMILLEN, W. N.

Jour. Am. Vet. Med. Assn. 113: 573-575. 1948. [*Journal Article 969 from the Michigan Agricultural Experiment Station*]

In order to investigate the nature and etiology of transmissible gastroenteritis of baby pigs, 11 baby pigs were exposed to the disease in several ways: the feeding of ground digestive tract from infected pigs, the feeding of bacteria-free filtrate of ground digestive tract, and by pen exposure.

The course of transmissible gastroenteritis of baby pigs in experimentally exposed pigs was as follows: An initial rise in temperature in the first 24 hours after exposure was followed by a gradual decline until the pigs became moribund about 4 to 6 days after exposure. During the second and third days there was often vomiting, loss of appetite, diarrhea (greenish yellow, pasty to watery feces), dehydration and weakness. After the third day the symptoms usually became more marked. None of the pigs exhibited any signs of recovering before they were killed for necropsy examination. The significant gross lesion seemed to be the hemorrhage in the wall of the stomach. Microscopically, the lesions appeared as necrotic foci in the mucosa, characterized by necrosis of the epithelial cells, hemorrhage, mucoid degeneration and infiltration by leukocytes, and associated with capillary and venule thrombosis and hemorrhage in the submucosa. The number of cases studied microscopically was small and so the findings may not be conclusive. Lesions of the intestine as described by Doyle and Hutchings were not noted although the diarrhea was often marked.

Pathogenicity of Corynebacterium renale for Rabbits

FEENSTRA, E. S., THORP, F., JR., AND GRAY, M. L.

Amer. Jour. Vet. Res. 10: 12-25. 1949. [*Journal Article 973 from the Michigan Agricultural Experiment Station*]

In order to determine the efficacy of the rabbit as an experimental animal for use in the study of bovine pyelonephritis, 22 white rabbits were inoculated intravenously with a suspension of *Corynebacterium renale* which had been grown as tryptose agar (Difco) at 37° C for 24 hours. These rabbits were

necropsied at intervals of one-half hour, 1, 2, 3, 4, 5, 6, 7, 9, 11, 18 and 19 days after inoculation. Hemoglobin determinations, total leukocyte counts, and differential leukocyte counts were made on alternate days. The heart blood, lungs, liver, spleen, kidney, ureters and urinary bladder were fixed in Zenker's fluid; paraffin sections prepared, and stained with hematoxylin and eosin and by the Gram-Weigert method for staining bacteria in sections.

The earliest change in the kidney was the accumulation of heterophils in the capillaries and collecting tubules, with congestion in the papillary region of the medulla on the second day. Following this, at 3 and 4 days after inoculation, necrosis and erosion of the papilla were found. Masses of bacteria were found in the remains of capillaries and tubules and in the debris in the pelvis. The heterophil was the predominant inflammatory cell found in the early lesion. On about the fourth day the renal pelvic mucosa appeared necrotic and the peripelvic tissues contained serous fluid, fibrin, erythrocytes and heterophils. Lymphocytes appeared on the sixth day and mononuclear phagocytes and active fibroblasts appeared on the seventh day. These latter three cells increased in number as time passed, while the heterophils decreased in number but never disappeared entirely. At 17 and 18 days there were changes in the cortex such as an increase in interstitial connective tissue, dilation and constriction of tubules and accumulations of lymphocytes. The blood picture was one characteristic of acute infections and showed changes such as an increase in leukocytes on the fourth day and an increase in percentage of heterophils with a decrease in percentage of lymphocytes in the differential leukocyte count.

Control of Mildew on Bean Plants by Means of an Antibiotic

FELBER, I. M. AND HAMNER, C. L.

Botanical Gazette 110 (2): 324-325. 1948. [*Journal Article 975 from the Michigan Agricultural Experiment Station*]

Acidione, a culture filtrate of *Streptomyces griseus*, was found to be very active against powdery mildew on bean plants. The disease can be completely controlled by spraying the infected plants with an aqueous solution of 5 ppm. of this antibiotic substance. After about 48 hours the mycelium with the conidia that covers the surface of leaves and stems is destroyed, without any harmful effect to the plant itself.

Prophyllactic treatments prevent the development of the fungus *Erysiphe polygoni*. Therefore, plants have been protected during their lifetime against mildew when treatments were continued in intervals of 6 to 10 days, corresponding to the production rate of new leaves, while control plants were severely infected.

Actidione is a product of the Upjohn Company, Kalamazoo, Michigan. It has previously been tested only on yeast and some human pathogens.

The effectiveness of minute amounts of an antibiotic substance in the control of a fungal plant disease opens possibilities for new methods of fungicidal control in greenhouses, fields, orchards and food storages.

Calculation of Size of Home Range

HAYNE, D. W.

Jour. of Mammalogy 30 (1): 1-18. 1949. [*Journal Article 981 from the Michigan Agricultural Experiment Station*]

A comparison is made between the principal methods now used for estimating size of home range from live-trapping records of small mammals. The home range

is the area over which an animal normally travels. The degree of intensity of use of various portions of the area is biologically significant, as well as absolute size. The commonly-used methods for estimating size of home range involve an assumption that animals do not range to any important degree beyond the areas where trapped.

A method is suggested for computing the location of a "center of activity", or point about which the points of capture tend to be grouped. It is shown that the probability of capture seems to decrease with increased distance from the center of activity.

The trap-revealed home range usually increases more rapidly with the first few captures, then less rapidly, and finally changes little with further captures. While this has been explained as an animal reaching the absolute limits of its home range, it is here shown to be a possible result of the mechanics of trapping.

The relationship between true home range and trap-revealed home range requires experimental analysis.

A Bacteriological Survey of the Reproductive Tract of Infertile Cows

HATCH, R. D., FEENSTRA, E. S., AND JENNINGS, L. F.

Jour. Am. Vet. Med. Assn. 114: 131-133. 1949. [*Journal Article 982 from the Michigan Agricultural Experiment Station*]

A preliminary bacteriological survey of the cervix and vagina of infertile dairy cows indicated that bacterial infection, either clinically apparent or not apparent may be responsible for many cases of infertility. The reproductive tracts were cultured by means of cotton swabs which were streaked out on skimmilk tryptose agar. The results of the bacteriological examination may be summarized in table form:

	Neg.	Pos.	G + rods	G + cocci
Cervical Smears	26	27	14	18
Vaginal Smears	2	5	3	3
Semen Samples	0	4	3	2

An Experimental Case of Pyelonephritis

FEENSTRA, E. S., GRAY, M. L., THORP, F., CLARK, C. F. AND HATCH, R. D.

M.S.C. Veterinarian 9: 15-17, 1949. [*Journal Article 983 from the Michigan Agricultural Experiment Station*]

The history, symptoms, blood analyses, urine findings and gross pathology of an induced case of pyelonephritis in one dairy heifer of three exposed by means of urocyst inoculation with *Corynebacterium renale* has been recorded. The blood creatinine values gradually increased throughout the course of the disease until death, indicating loss of functional tissue. The hemoglobin values decreased. There was no marked increases in numbers of leukocytes, but there was an occasional increase in the number of neutrophils. *C. renale* and erythrocytes were present in the urine throughout the course. Occasionally the heifer showed colicy pains and refused to eat. At necropsy, 77 weeks after inoculation, the kidneys were scarred, shrunken and filled with calculi.

Quality Factors Affecting the Price of Peaches on the Benton Harbor Market

HATHAWAY, D. E. AND CRAVENS, M. E.

Jour. Farm Econ. 3 (1): 631-634. 1949. [*Journal Article 988 from the Michigan Agricultural Experiment Station*]

Peach prices fluctuate widely. The purpose of this study was to determine the amount and causes of peach price fluctuations which were due to factors

within the control of the grower. Observations were made on the Benton Harbor Fruit Market during the 1947 season of about 400 individual sales of peaches. All pertinent data regarding the quality of the peaches, details of the sale and price were recorded for each sale. These included general appearance, firmness, defects, percentage of red color, shade of red and green color, presence or absence of colored shredded paper, size of load, type of package, time of sale, location on market and other factors.

Appearance was the most important factor affecting price between the lots of peaches studied. Halehavens with excellent appearance brought 37 cents per bushel more than those with only fair appearance. Good appearance was associated with a high percent of red color, the presence of shredded paper, and brushing.

Firmness also significantly affected price. Over half the Halehavens sold were too soft to bring top prices, while over 90 percent of the Elberta peaches sold were too hard. This indicates a possibility for further study in the methods of determining and controlling ripeness.

Defects caused significant differences in price, especially where they indicated poor shipping quality of the peaches. Market imperfections were not important as causes of price variations.

An adaptation of the analysis of variance technique, with the F test, were used to test significance of results. The Chi square test was used to test the relationship of various factors to appearance. The study emphasized the value of tests of significance for sorting out some of the apparently significant relationships. It also indicated a need for a method of assigning accurate numerical designations to non-numerical factors such as appearance and brushing.

The Clinical Use of Sulfamerazine on Infections in Dogs and Cats

Eads, F. E.

North American Veterinarian 30: 244-249. 1949. [*Journal Article 991 from the Michigan Agricultural Experiment Station*]

Sulfamerazine was used on 52 dogs and 2 cats showing clinical distemper, pleuritis, bronchitis, tonsillitis, laryngitis, pharyngitis, or rhinitis. When administered at the rate of approximately one grain per pound of body weight two to four times daily very favorable results were obtained. The tablets may be crushed and given in powder form with similar results.

Transmission of Cherry Yellows Virus Complex Through Seeds

Cation, D.

Phytopathology 39 (1): 37-40. 1949. [*Journal Article 995 from the Michigan Agricultural Experiment Station*]

Mahaleb and Montmorency seed collected from trees apparently infected with the cherry yellows virus complex were germinated in February and grown 4 months in the greenhouse. Grafts from the Mahaleb seedlings to seedling peach indicated over 20-percent disease transmission, with half of the infected peach trees showing ring spot and the other half showing typical cherry yellows symptoms. Similar inoculations from Montmorency seedlings resulted in over 30-percent disease transmission but only the ring spot virus was transmitted through Montmorency seed. Uninoculated peach trees of the same lot served as controls and grew normally without symptoms.

Fractures of the Mandible

BRINKER, W. O.

Veterinary Medicine 44 (2): 53-55. 1949. [*Journal Article 1004 from the Michigan Agricultural Experiment Station*]

The incidence of fractures of the mandible in small animals is increasing, the primary cause being collision with automobiles. Methods of immobilization are presented. Fractures in the region of the symphysis may be immobilized by either or a combination of interdental wiring and right-angle pin fixation. Fractures of the rami may be immobilized by one or a combination of the following: interdental wiring, bone plates, Kirschner splints and intramedullary pinning. Pin fixation is a favorite method because of the ease of application, less equipment, and it is well tolerated by the animals.

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